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State of Connecticut

REPORT

OF

The Connecticut Agricultural Experiment Station

NEW HAVEN, CONN.

TWELFTH REPORT OF THE STATE ENTOMOLOGIST, 1912

W. E. BRITTON, PH.D.

BEING PART III OF THE ANNUAL REPORT OF 1912

TWELFTH REPORT

OF THE

STATE ENTOMOLOGIST

OF

CONNECTICUT

FOR THE YEAR 1912

BY

W. E. BRITTON, PH.D.

State Entomologist

New Haven, Conn.

1913

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ILLUSTRATIONS.

Figures 1 and 2 are from Smith's Report on New Jersey Mosquitoes. Plates III, a, c, d, and e, and VI, a, b, and c, are from original pen drawings by Mr. A. B. Champlain. Plate XV, c, is from a pen drawing by Mrs. E. L. Beutenmuller, from the report of this Station for 1909, page 373. The other illustrations on Plates IV to VI, VII, b and c, VIII, IX, b, and XVI, a and b, are from original photographs by Mr. H. B. Kirk. Plate IX, c, is from photograph by the late H. A. Doty. All other illustrations are from original photographs by Mr. B. H. Walden.

PART III.

TWELFTH REPORT

OF THE

State Entomologist of Connecticut

To the Director and Board of Control of the Connecticut Agricultural Experiment Station:

I transmit herewith my twelfth report as State Entomologist of Connecticut. It contains an account of the activities of my office for the calendar year of 1912, but as in previous reports the statements regarding finances and the inspection of imported nursery stock apply to the State fiscal year ending September 30th.

Respectfully submitted,

W. E. BRITTON,
State Entomologist.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST FROM OCTOBER 1ST, 1911, TO SEPTEMBER 30TH, 1912.

Insect Pest Account.

RECEIPTS.

From E. H. Jenkins, Treasurer	$3,000.00
Account of 1911, balance	765.99
Miscellaneous	12.93
	$3,778.92

EXPENDITURES.

For Field, office and laboratory assistance:		
B. H. Walden, salary	$1,080.00	
H. B. Kirk, salary	562.50	
D. J. Caffrey, salary	219.00	
E. B. Whittlesey, salary	301.00	
F. M. Valentine, salary	150.00	
Other assistance	110.13	
		$2,422.63

Printing and illustrations	$281.88	
Postage	56.02	
Stationery	17.35	
Telegraph and telephone	3.90	
Express, freight and cartage	6.65	
Library	184.67	
Laboratory apparatus and supplies	97.51	
Office supplies	57.32	
Traveling expenses	390.88	
Balance, cash on hand	260.11	
		$3,778.92

Gypsy Moth Control Account.

RECEIPTS.

From E. H. Jenkins, Treasurer	$2,500.00
Account of 1911, balance	168.97
	$2,668.97

EXPENDITURES.

For Salary, labor, board of scouts, etc.:			
D. J. Caffrey, salary	$ 766.00		
Labor, board of scouts, etc.	1,268.79		
		$2,034.79	
Printing and illustrations		2.40	
Tools and supplies		54.84	
Telegraph and telephone		.25	
Express, freight and cartage		1.98	
Traveling expenses		343.64	
Balance, cash on hand		231.07	
			$2,668.97

Memorandum:—This account of the State Entomologist has been duly audited by the State Auditors of Public Accounts.

PUBLICATIONS OF THE ENTOMOLOGICAL DEPARTMENT, 1912.

By W. E. BRITTON:

Eleventh Report of the State Entomologist (Part IV of Station Report for 1911): 88 pages, 10 text figures, 16 plates; 9,000 copies distributed in March, 1912.

Report of Committee on Injurious Insects: Proceedings Connecticut Pomological Society, 1912, p. 37, 4 pages.

Progress in Exterminating Two Isolated Gypsy Moth Colonies in Connecticut. *Journal of Economic Entomology,* Vol. V, p. 194, 2 pages, April, 1912.

Spread of the Leopard Moth in Connecticut and Its Injury to Shade Trees. *Journal of Economic Entomology,* Vol. V, p. 241, 2 pages, June, 1912.

The House Fly as a Disease Carrier and How Controlled. Bulletin Connecticut State Board of Health, 10 pages, 1 plate, June, 1912.

The Rôle of the House Fly and Certain Other Insects in the Spread of Human Diseases. *Popular Science Monthly,* Vol. LXXXI, p. 36: 14 pages, 5 figures, July, 1912.

The Mosquito Plague of the Connecticut Coast Region and How to Control It. Bulletin 173 of this Station: 14 pages, 4 plates; 10,000 copies, July, 1912.

Review of Sanderson's "Insect Pests of Farm, Garden and Orchard," *Science,* June 14, 1912.

The Leopard Moth (Summary of Bulletin 169 of this Station) with Illustrations. *Connecticut Farmer,* January 13, 1912.

Inspection of Apiaries in 1911, *Connecticut Farmer,* February 24, 1912.

Inspection of Imported Nursery Stock in Connecticut, *Connecticut Farmer,* June 15, 1912.

Improvement of Salt Marshes, *Connecticut Farmer,* August 3, 1912.

The House Fly and Its Relation to Typhoid Fever, Proceedings of the Sixth Sanitary Conference of the Health Officers of Connecticut (with discussion); 17 pages, October, 1912.

Notes of the Year from Connecticut, *Journal of Economic Entomology,* Vol. V, p. 464, December, 1912, 2 pages.

Inspection of Apiaries in 1912, *Connecticut Farmer,* November 23, 1912.

By G. P. CLINTON and W. E. BRITTON:

Test of Summer Sprays on Apples, Peaches, etc. (Part V, Report of this Station for 1911), 60 pages, 8 plates. 9,500 copies, May, 1912.

By B. H. WALDEN:

Common Household Insects. *Connecticut Farmer,* March 16, 1912.

White Pine Weevil, *Connecticut Farmer,* July 6, 1912.

ENTOMOLOGICAL STAFF.

W. E. BRITTON, Ph.D. ..... *State and Station Entomologist.*
B. H. WALDEN, B.Agr. ..... *First Assistant.*
DONALD J. CAFFREY, B.S. ..... *Assistant.*
HARRY B. KIRK* ..... *Assistant.*
MISS E. B. WHITTLESEY† ..... *Stenographer.*
MISS FRANCES M. VALENTINE‡ ..... *Stenographer.*

Mr. Walden has continued as assistant and takes charge of all work in my absence from the office. Mr. Caffrey has been in charge of all field work in suppressing the gypsy and brown-tail moths, and when not needed there has helped in the inspection of nurseries. Mr. H. B. Kirk was engaged to fill the place of Mr.

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* Beginning February 15th, 1912.

† Until August 1st, when transferred to botanical department.

‡ Employed temporarily June 17th and regularly since August 1st.

A. B. Champlain, who resigned October 1st, 1911. Mr. Kirk began his work February 15th, 1912, and came to Connecticut from the Division of Economic Zoölogy, Harrisburg, Pa. Mr. Kirk has aided in the inspection of nurseries and of imported nursery stock and has studied the walnut weevil and bud-moth during the summer and also made observations on white pine insects. He specializes in the beetles (order Coleoptera) and has spent considerable time on the collection. He will also assist Mr. Caffrey in scouting for gypsy moth egg masses and brown-tail nests during the winter.

Mr. J. Kirby Lewis, a student of the Massachusetts Agricultural College, was employed during his summer vacation, from June 18th to September 7th, as a general laboratory assistant. So far as is practicable, local help has been employed in the gypsy moth work at Wallingford and at Stonington, and in part on the brown-tail work in the northeastern corner of the State.

Messrs. H. W. Coley of Westport and A. W. Yates of Hartford have continued as apiary inspectors and are paid by the day for the time employed.

Miss E. B. Whittlesey continued to work half of each day as stenographer, until her vacation, July 1st. Miss Frances M. Valentine was employed June 17th to do some special clerical work and to fill the position of stenographer during July. On Miss Whittlesey's return, August 1st, she was transferred to the Director's office for a time and later to the botanical department and Miss Valentine was given a position in this department, working full days, the extra work being necessary.

Much of the success of the work of the department is due to the faithfulness and efficiency of the persons mentioned above, and their services are not unappreciated.

Chief Lines of Work.

Certain routine and police duties are required by law of the State Entomologist, such as suppressing the gypsy and brown-tail moths, the annual inspection of nurseries, the inspection of apiaries on complaint, and the examination of orchards on request. In addition to these prescribed duties for the past four years an attempt has been made to inspect all woody field-grown imported stock to safeguard the State against insect and fungous

pests liable to be introduced in this way. The inspection work in each of its several divisions is described more in detail in the following pages.

Some studies of scientific value have been made during the year. Mr. Kirk devoted a portion of his time in the summer months to investigating the life history, habits, and damage of the walnut weevil, *Conotrachelus juglandis*, Lec. This work, except for further tests of remedial treatment, has been completed, and a comprehensive account of it is given on page 240 of this report. Mr. Kirk also studied another insect, a bud-moth, of the genus *Acrobasis* which causes much injury to walnuts and often works conjointly with the walnut weevil. The results of this work appear in the paper on page 253.

For three years Mr. Walden has made observations on a species of sawfly which he found defoliating cultivated blackberries in a field near New Haven. During the past season he obtained sufficient data to complete his knowledge of the life history of this insect. The species being a new one, was described recently as *Pamphilius dentatus* by Prof. A. D. MacGillivray. The article on page 236 of this report contains all the known facts regarding this insect.

A start has been made in a study of the white pine weevil, *Pissodes strobi* Peck, and other insects attacking pine trees in Connecticut, but several seasons will probably be necessary to obtain the data that would warrant publishing a report.

Some attention has been given to the general care of the orchard trees on the Station farm at Mt. Carmel, where several minor investigations are still in progress.

The control of the mosquito nuisance was actively taken up by several organizations and individuals, during the season, and this office has endeavored to coöperate wherever and whenever possible by furnishing information and advice, and in a number of cases has sent an expert to examine and report upon the suspected territory and to inspect drainage or oiling work. A fuller report of this phase of our work is given on pages 259-288.

There has been a greater demand for popular lectures than ever before, especially regarding the housefly and the mosquito, subjects connected with public health. These demands have been met, if possible, and in most cases the lectures have been illustrated with lantern slides, charts or specimens. Of the thirty

lectures given during the year by Messrs. Britton and Walden, twelve have been illustrated with lantern slides, and twenty-one (eight illustrated) have dealt with flies and mosquitoes.

There has also been a considerable increase in the correspondence and other clerical work of the office.

In connection with the general station exhibit the entomological department made an exhibit of its work at three agricultural fairs as follows:

Norfolk Agricultural Association, Norfolk	Sept. 19–20
State Fair, Berlin	Sept. 24–28
Suffield Fair, Suffield	Oct. 1– 2

This department exhibit was similar to that of last season described in the Report of 1911, p. 264, though somewhat less space was occupied, about 1,200 square feet being used. The mosquito exhibit was made more of a feature than previously and a number of new charts and enlarged photographs added considerably to the appearance of the display.

Summary of Inspection and Office Work, 1912.

315 samples of insects received for identification.
53 nurseries inspected.
52 regular certificates issued.
7 parcel certificates issued.
31 orchards and gardens examined.
987 boxes and packages imported nursery stock examined.
153 apiaries containing 1431 colonies inspected.
73 apiaries containing 337 colonies found infested with European foul brood and treated.
2746 letters written on official work.
179 mail and express packages sent out.
432 bulletins mailed on request or to answer inquiries.
30 lectures and addresses made before granges, clubs and civic organizations.

Entomological Features of 1912.

The winter of 1911-12 was characterized by low temperatures and the ground remained frozen nearly all of the time from December until March. The ground was covered with ice but there was little snow.

Many trees in orchards and in woodlands were apparently injured, either directly by the winter, or, possibly, by the drought of 1911, followed by rains, stimulating a late growth which was

easily damaged by the freezing. At any rate, the buds were killed in nearly all peach orchards, except near the coast, and many oak trees have died during the drought of July and August, 1912, which were probably injured the previous winter. A number of others, half-dead, show signs of winter injury to roots or stems. The cool, moist weather of May favored a luxuriant foliage development on trees, and after the few hot, sunny days of June and July leaf scorch troubles developed on many trees, especially sugar maples.

Seasonal conditions, especially absence or abundance of moisture, winter changes and low temperature have a direct or indirect effect on the scarcity or abundance of the various kinds of insects. The cold, wet spring seemed favorable to the increase of aphids and nearly all kinds were abundant. The rosy apple aphis, *Aphis sorbi* Kalt., was more prevalent and caused more damage than since 1909, many orchards being seriously injured and the fruit stunted by it. The green apple aphis, *A. pomi* DeG., was also common but it causes less injury to bearing trees than *A. sorbi* and its principal damage consists in checking the growth of young trees in orchards and nurseries.

Perhaps the most prominent feature of the season was the great abundance of white grubs (*Lachnosterna* sp.) and the damage caused by them. There were many complaints and several specimens were sent to this office. Evidently the drought favored them as they did more damage than I have seen during a residence of eighteen years in the State. Not only were grass fields attacked and injured, but corn, strawberries and potatoes were also damaged and in some cases nearly destroyed by the grubs. In a forest nursery near New Haven, nearly twenty-five per cent. of the seedling conifers and some deciduous trees were eaten off below the surface of the ground.

The fall army worm, *Laphygma frugiperda* S. & A., was received from Stonington, Groton and from two different localities in New Haven. In three of these places the caterpillars were devastating lawns, and in the other case they were feeding upon a field of millet.

The birch leaf skeletonizer, *Bucculatrix canadensisella* Chamb., though much less abundant than in 1910, was found over the entire State as in 1911, and was particularly noticeable on the yellow birches in Litchfield County in September. It was also

received at this office on cut-leaf and other ornamental birches from various localities.

The leopard moth, *Zeuzera pyrina* Linn., which was fully described in Bulletin 169 and in the report of 1911, continues its destructive work on the shade trees of the shore towns and cities.

The gypsy moth, *Porthetria dispar* Linn., has apparently been exterminated at Stonington, and nearly so at Wallingford. The brown-tail moth, *Euproctis chrysorrhoea* Linn., is spreading a few miles each year towards the south and east. In time it will doubtless spread over the entire State. Though it is held in check by its natural enemies and by the destruction of winter nests and by spraying, it cannot be wholly eradicated as can small colonies of the gypsy moth, because both sexes fly. Detailed accounts of our work against both these insects will be found in this report.

Cut-worms were fairly abundant in June and did their usual amount of injury.

The elm leaf beetle, *Galerucella luteola* Mull., though causing little injury in towns where spraying was thoroughly and universally practiced, ravaged the unsprayed trees in many places, including the roadside and meadow trees of the open country. This insect seems to be now particularly prevalent in the northwestern portion of Connecticut.

The fall canker-worm, *Alsophila pometaria* Harr., as in past seasons, continues to damage apple and elm trees in certain localities.

The spiny elm caterpillar, *Euvanessa antiopa* Linn., was received from a number of correspondents in various portions of the State. Though possibly not as abundant as in 1911, it was nearly as prevalent. Persons often mistake the larvæ for gypsy caterpillars, but the resemblance is slight.

Injury was reported to fruit by the rose chafer, *Macrodactylus subspinosus* Fabr., and the bumble flower beetle, *Euphoria inda* Linn. The white marked tussock moth caterpillars, *Hemerocampa leucostigma* S. & A., were feeding upon a California privet hedge in New Haven in July. The red-humped caterpillar, *Schizura concinna* S. & A., and the yellow necked caterpillar, *Datana ministra* Dru., were in their usual abundance devouring the leaves of young fruit trees late in the season.

The San José scale, *Aspidiotus perniciosus* Comst., was present as usual, and in certain orchards, though thoroughly sprayed, the fruit showed considerable infestation at harvest time. The oyster shell scale, *Lepidosaphes ulmi* Linn., and the scurfy scale, *Chionaspis furfura* Fitch, are present in rather constant numbers year after year but do no very serious damage in Connecticut orchards which otherwise receive good care.

The scale insects which at present attract the most attention are the tulip tree scale, *Toumeyella liriodendri* Gmel., and the woolly maple leaf scale, *Phenacoccus acericola* King. The pine bark aphis, *Chermes pinicorticis* Fitch, is seemingly on the increase and many inquiries regarding it have been received.

The cotton moth, *Alabama argillacea* Hubn., which attracted attention late in September, 1911, by its abundance in its northward flight, also appeared October 11th and 12th, of this year, but in much less numbers than in 1911, and more than two weeks later in the season.

The season of 1912 was a notable one on account of the great abundance of mosquitoes. The frequency of the high tides, together with the long period during which the salt marshes were flooded, gave the salt marsh species a favorable opportunity for multiplying, and they took advantage of it. Thus where no control measures were adopted the salt marsh mosquito, *Culex sollicitans* Walk., was extremely abundant late in the summer, and the rain barrel or house mosquito, *Culex pipiens* Linn., was likewise common and was the source of much annoyance.

INSPECTION OF CONNECTICUT NURSERIES.

The annual inspection of nurseries as required by law was commenced August 26th and finished about the middle of October. The work was done by Messrs. Walden, Caffrey, Kirk and Lewis. Two nurseries were inspected twice, once in the spring and again in the fall. The nursery business is on the increase in Connecticut and a number of the nurserymen have increased their area of growing nursery stock. When this office was established in 1901, the first list of Connecticut nurserymen receiving certificates contained twenty-five names. About half of those nurserymen are still in the business, and the present list has fifty names.

Nursery Firms in Connecticut Receiving Certificates in 1912.

Name of Firm.	Location.	Certificate issued.	Number of certificate.	Number of acres in nursery.	Kind of stock grown.
Barnes Brothers Nursery Co.	Yalesville	Oct. 8	490	134	Three-fourths fruit; ornamental.
Beattie, Wm. H.	New Haven	" 21	505	1*	Ornamental only.
Bowditch, J. H.	Pomfret Center	Aug. 23	470	8	Rare ornamental.
Brainard Floral and Nursery Co.	Thompsonville	Oct. 1	480	4	Ornamental.
Braley & Co., S. A.	Burnside	Sept. 30	477	1	Fruit and ornamental.
Bretschneider, A.	Danielson	Oct. 5	485	2	Fruit and ornamental.
Brooks Brothers	Westbrook	Nov. 6	511	2	Ornamental.
Burroughs, Thos. E.	Deep River	Oct. 5	482	1	Ornamental; fruit.
Burr & Co., C. R.	Manchester	Sept. 17	473	300	Chiefly fruit; ornamental shrubs.
Chapman, C. E.	North Stonington	Oct. 5	486	4	Small fruits.
Comstock & Lyon	Norwalk	" 24	506	30	Chiefly ornamental; fruit stock.
Conine Nursery Co., F. E.	Stratford	" 5	483	34	Chiefly ornamental.
Conn. Agricultural College (Prof. A. G. Gulley)	Storrs	" 12	494	5	Chiefly fruit.
Conn. Agricultural Experiment Station (W. O. Filley, State Forester)	New Haven	Nov. 6	512	2	Forest tree seedlings; chiefly conifers.
Conway, W. B.	New Haven	Oct 5	488	1	Ornamental.
Cross Highway Nurseries	Westport	" 15	496	10	Chiefly ornamental; some fruit.
Dehn & Bertolf	Greenwich	Sept. 26	476	25	Miscellaneous ornamental.
Dwyer, John E.	Manchester	" 13	472	1	Ornamental.
East Rock Park Nursery (G. X. Amrhyn, Supt.)	New Haven	Oct. 29	508	8	Ornamental and shade trees.
Elm City Nursery Co.	New Haven	Sept. 7	471	100	Ornamental and miscellaneous; conifers.
Gardner's Nurseries	Cromwell	Oct. 15	497	10	Two-thirds fruit; ornamental.
Hartford Park Commissioners (G. A. Parker, Supt.)	Hartford	Dec. 3	517	5	Ornamental only.
Heath & Co., H. S. (2)	Manchester	Sept. 30	479	1	Fruit.
Hilliard, H. J.	Sound View	Nov. 11	513	1	Ornamental.

*One acre or less. Fractions have been omitted.

* One acre or less. Fractions have been omitted.

Nursery Firms in Connecticut Receiving Certificates in 1912—*Concluded.*

Name of Firm.	Location.	Certificate issued.	Number of certificate.	Number of acres in nursery.	Kind of stock grown.
Houston & Sons, J. R.	Mansfield Depot	Oct. 5	484	1	Fruit.
Hoyt's Sons Co., Stephen	New Canaan	Sept. 30	478	300	Fruit, ornamental and shade trees.
Hubbard & Co., Paul M.	Bristol	Oct. 11	493	12	Chiefly fruit; ornamental.
Hunt & Co., W. W.	Hartford	Sept. 24	475	10	Mostly ornamental.
Kellner, H. H.	Danbury	Oct. 19	502	3	Fruit, chiefly apple.
Kelsey & Sons, David	West Hartford	" 16	499	2	Fruit and asparagus.
Mount Carmel Forestry and Nursery Co. (C. A. Metzger, Manager)	Hartford	" 19	504	3	Forest tree seedlings, conifers.
Munro, Chas.	New Haven	" 5	487	1	Ornamental only.
New Haven Nurseries Co.	New Haven	Sept. 23	474	7	Ornamental.
Northeastern Forestry Co.	Cheshire	Oct. 19	503	5	Forest tree seedlings, chiefly conifers.
Phelps, J. Wesson	Bolton	Nov. 23	515	1	Asparagus and small fruits.
Pierson, A. N.	Cromwell	Aug. 23	469	1†	Ornamental.
Platt Co., The Frank S.	New Haven	Nov. 22	514	1	Fruit and ornamental.
Purinton, C. O.	Hartford	" 4	510	1	Fruit and ornamental.
Reck, Julius	Bridgeport	Oct. 28	507	1	Chiefly ornamental; fruit.
Ryther, O. E.	Norwich	" 14	495	8	Wholly ornamental.
Schleichert, F. C.	Bridgeport	Dec. 12	518	2	Ornamental stock only.
Scott, J. W.	Hartford	Oct. 18	501	4	Chiefly ornamental; some fruit.
Seavey, Wallace	Waterbury	" 31	509	1	Ornamental.
Sierman, C. H.	Hartford	" 17	500	4	Ornamental and fruit.
Stanhope, B. P.	Niantic	Nov. 27	516	2	Fruit.
Streckfus, H. P.	Litchfield	Oct. 4	481	3	Ornamental.
Turner & Co., Chas.	Hartford	" 9	492	5	Ornamental and fruit.
Vidbourne & Co., J.	Hartford	" 9	491	10	Ornamental.
Woodruff, C. V.	Orange	" 16	498	3	Miscellaneous.
Young, Mrs. Nellie A. (2)	Pine Orchard	" 7	489	1	Ornamental.
Total area devoted to nursery stock				1082	

† Large wholesale florist; many acres under glass.

In 1902, just ten years ago, statistics were gathered showing that the thirty-one nurseries contained about 422 acres. Similar data has been collected the present season and there are now fifty nurseries, containing about 1082 acres.

Fifty-three nursery inspections were made during the year and fifty-two certificates issued.

On the whole the nurseries are each year paying more attention to treating their stock to destroy insect pests, consequently their condition as regards San José scale has greatly improved during the past few years. On account of the danger of distributing certain other pests, which are liable to be found on nursery stock, the Connecticut nurseries are now given a closer inspection than ever before.

Some chestnut trees in one nursery had the chestnut bark disease and were destroyed.

In addition to the regular inspection of growing nursery stock, inspections of several packages have been made at the request of persons who are not nurserymen, but wish to ship certain kinds of stock to other states. Seven package certificates have been issued during the year. Of the names published in the nurserymen's list of last year, two have gone out of the business, one has moved his business into an adjoining State, and the others are on the present list. Four new names have been added.

On pages 218 and 219 is a list of the nurserymen and firms receiving certificates in 1912, together with statistics regarding the area and kind of stock in each nursery. In most cases the acreage given is that supplied by the owner, but in some instances it is the estimate of the inspector.

INSPECTION OF IMPORTED NURSERY STOCK IN CONNECTICUT.*

By W. E. Britton and B. H. Walden.

For the past few years there has been a great increase in the amount and value of the nursery stock imported into the United States from European and other countries. In the natural course of events we should expect that many species not commonly cultivated, horticultural varieties and novelties would be brought

*A portion of this article was printed in the *Connecticut Farmer*, June 15, 1912.

into this country for the purpose of increasing the variety of plants available for ornamental planting and of introducing worthy commercial varieties, but we often wonder why such things as California privet, Japanese barberry and the common spiræas, which can be and are so easily grown here, should be imported in such quantities, especially when there is quite a heavy duty to be paid on such stock.

The chief reasons for the heavy importations are the low prices of labor in Europe, and the fact that soil and climate in certain localities there produce fine plants. Were these the only factors to be considered, such importations would be a benefit, not only to the United States, but also to the countries where the stock is grown. But there are insect and fungous pests in all lands, and a number of them have been brought into the United States on nursery stock, so that the traffic is not an unmixed blessing. Our Government has never established any system of inspecting such stock except for customs duties.

No other important nation lacks such a system of inspection. A few years ago, dead San José scales were found on some dried apples and other fruit shipped into Germany; forthwith all American dried fruits were debarred from Germany. Far more dangerous infestations have been found on nursery stock brought here from Germany, France, England, Holland and Japan, yet until October 1st, 1912, the United States has had no inspection system other than that provided in the separate states, and almost no restrictions on the entrance of such stock.

Early in 1909, winter nests of the brown-tail moth were found on stock from France, shipped into a number of states, including Connecticut, and had it not been for the inspection officers in the separate states, who destroyed all nests found, the whole country would now be infested by this most undesirable addition to our insect fauna.

Previous to 1909, no attempt was made to inspect imported stock in Connecticut, but in order to protect the State and its varied horticultural and agricultural interests, such inspection was given, though there was no provision for it except that the law providing for the control of the gypsy and brown-tail moths, enacted in 1907, liberally interpreted, permitted it.

In 1909 and 1910, brown-tail nests were found on fruit seedlings imported from France, but since then none have been found,

though in a number of cases trimmed branches with part of the web remaining showed that the stock had been infested. A number of other kinds of insects, some of which are known to be pests, have been found during the inspections and destroyed. The white pine blister rust has been detected in two or three shipments, and in the spring of this year an importation of 5,000 young pines was destroyed because infested by this disease. Last year a similar disease of junipers from Japan was brought into this State, and as in one of its stages it is injurious to pomaceous fruit in Japan, serious damage might be expected to follow its introduction into Connecticut. We have too many pests already; still, there are several important ones in Europe, and no doubt in other countries, not yet known to be in America. If any one of these becomes established in Connecticut or any other State, the entire country is endangered.

In the season just closed 987 boxes, bales and packages have been inspected by members of the entomological staff. This is more than ever before in a single year, and includes only the hardy plants and woody stock for florists. No attempt has been made to inspect seeds, bulbs, lily-of-the-valley pips, or tender herbaceous plants. Moreover, a number of small shipments of nursery stock could not be inspected because the stock was received and distributed before we were notified of its importation. We have received notice of the arrival of more than 550 boxes, etc., of bulbs and other plant material which we made no attempt to examine, and of about 25 boxes, etc., which could not be traced or found at their point of destination.

The following table shows the amount and source of such stock examined by this office for the past four seasons:

	1909	1910	1911	1912
Belgium	2	91	15	269
England	16	63	91	26
France	71	104	154	97
Germany	93	9	2	9
Holland	109	376	449	534
Ireland	..	18	14	14
Japan	6	26	109	25
Russia	..	1	..	..
Scotland	..	19	2	12
Miscellaneous or unknown	9	..	18	1
Total	306	707	854	987

Congress, at its last session, established the Federal Horticultural Board and provided for a system of applications and permits before any nursery stock can enter the United States, and also gave this Board the right, after due notice and hearings, to establish and enforce quarantine regulations against any country or portion of a country where any serious insect pest or plant disease exists, which is liable to be brought into the United States. This Board also has a similar right to quarantine states or portions of states in this country for the same reasons. This law became operative October 1st, 1912.

The Federal Horticultural Board does not attempt to inspect any stock consigned to the various states having inspection systems, but leaves it to the State inspectors. It does attempt, however, to notify the inspectors regarding the arrival of the stock at the ports of entry. The notice gives the number of the permit issued, name of grower or consignor, name and address of consignee and locality where stock was grown. This enables us, for instance, to trace the stock more easily than we have been able to do in the past, and should result in a careful inspection of a larger proportion of the imported stock needing inspection which is brought into the State. Only field-grown woody plants require inspection under this act. No attempt will be made to inspect herbaceous nursery or florist's stock.

At the present time there is no State provision for this work, but it is important as it safeguards and protects the State from introducing pests in this manner, and there should be some definite provision for its continuance.

INSPECTION OF APIARIES IN 1912.

The inspection of apiaries has been conducted in much the same manner as last year and Messrs. A. W. Yates of Hartford and H. W. Coley of Westport have continued to act as inspectors. An effort was made, however, to inspect apiaries in those portions of the State not previously covered in the work, and considerable European foul brood was found in Litchfield, Torrington, Winchester and Barkhamsted in Litchfield County and some was found in Norwich and Stonington in New London County. Very few apiaries have previously been inspected in these two counties, as no complaints have been filed requiring attention.

In nearly all sections of the State, where apiaries are examined, foul brood is found, and in some cases it does much damage, killing off colonies of bees before its presence is known. Wherever the proper treatment is given, there seems to be no trouble in controlling the disease and in most cases it disappears altogether.

As three hundred dollars is the limit of the appropriation to be expended in any one year, the entire State cannot be covered in a single season. The beekeepers seem to be pleased with the inspection service and treatment, so far as it goes, but at their last meeting they voted to ask for an increased appropriation; and for certain changes in the laws giving authority to inspect without complaints; to place a quarantine upon diseased apiaries; and requiring that a certificate of good health accompany each shipment of bees, whether brought into the State from without or moved from one point to another within the State.

The statistics given below show a summary of the inspection work for the season:

APIARIES INSPECTED, 1912.

	Apiaries.	Colonies.
Number inspected	153	1431
Infested, European foul brood	73	337
Other troubles:		
Pickled Brood	several	
Doubtful	3 cases	
Diseased Adult Bees	6 cases	
Average number of colonies per apiary	9.3	
Total cost of inspection	$299.80	
Average cost of inspection per apiary	1.96	
Average cost of inspection per colony	.21	

GYPSY MOTH CONTROL WORK IN 1912.

By W. E. BRITTON AND D. J. CAFFREY.

Stonington Infestation.

No caterpillars have been found in Stonington since the summer of 1910 and it is probable that the gypsy moth has been eradicated from that locality. Nevertheless, the place will be watched. Mr. Caffrey, in company with two Federal scouts, examined Stonington, beginning January 4th, 1912, and finishing

January 20th. No egg-masses were found. Nevertheless, the trees were banded the following summer, the bands examined for caterpillars and much scouting done in and around the area formerly infested. No gypsy caterpillars were found. Mr. Fred Hoadley was employed on this work and had immediate charge under our direction of applying, examining and removing the bands. Mr. Hoadley commenced work on May 13th, and finished August 17th. Mr. Caffrey spent three days in July scouting in Stonington.

Number of burlap bands	2210
Number of tanglefoot bands	66

Wallingford Infestation.

An account of the scouting operations at Wallingford, during the autumn and winter of 1911, appears in the last report of this Station (see Report for 1911, page 279). At that time five egg-masses were found through the combined efforts of the State and Federal scouts.

The summer work began on May 13th, and on May 14th tanglefoot bands were applied to 128 trees, including all the spruce and cedar trees in the cemetery and several large hickory, walnut and spruce trees about town. This tanglefoot was stirred from time to time to keep it in a viscid condition.

Commencing on May 15th the burlap bands were placed on all the trees, to the number of 5,379, in the area between North Main, Christian, Cherry, Ward and Fair streets. The area thus treated was somewhat smaller than that of the previous two years, due to the diminished size of the territory where egg-masses and caterpillars were found the year before. Two men were employed to examine these bands at regular intervals from May 23d until August 15th. During this period many suspected trees, especially rough-barked maples and elms, were climbed in search of caterpillars, and in addition all shrubbery and vines, impossible to band with burlap, were examined, as well as some of the territory outside the banded area.

The first caterpillar, one-half inch in length, was found June 1st, under the burlap around a large maple tree in front of "The Woodbine" on Center street. On June 10th, fifteen caterpillars

were found in the rear of the First National Bank, on Main street, feeding on apple and wild plum. The next day all of the foliage in this vicinity was sprayed with lead arsenate, at the rate of 2½ pounds, of the powdered form, to 50 gallons of water. On June 14th, six more caterpillars were found in the same yard. On June 19th, two caterpillars were found in an adjoining yard. From this time until the end of the season the trees, bushes, fences and outbuildings in this immediate section were examined nearly every day for caterpillars.

The first pupa appeared in the breeding cage on July 6th. On July 22d a pupa was found under the burlap on a maple tree in front of Grosse's, on South Orchard street. The next day this tree was looked over with the aid of a ladder and two full-grown caterpillars found. Careful search of the trees and bushes surrounding this spot failed to reveal any further signs of infestation.

The first adult, a male, emerged in the breeding cage on July 27th. During the last part of the season some search was made for egg-masses on the trunks, fences, etc., where the foliage did not interfere, but none were found.

This work on the trees and the turning of burlap was continued until August 15th, when the burlap bands were removed from the trees and burned; the summer work closing on August 17th.

The result of the work this season shows that twenty-six caterpillars were found and one pupa. It is possible that some caterpillars were killed by the arsenical poison, although none were observed after the spraying. All the caterpillars were found within a very small area, compared with that originally infested, and this fact, together with the small number of egg-masses, caterpillars and pupæ found within the past year, seems to indicate that the insect is well under control at Wallingford.

GYPSY MOTH STATISTICS, WALLINGFORD, 1912.

Egg-masses destroyed	5
Caterpillars destroyed	26
Cocoons destroyed	1
Trees banded with burlap	5379
Trees banded with tanglefoot	128
Trees sprayed (not including shrubs)	11
Trees infested (not including shrubs)	6

Scouting for the Gypsy Moth in the Northwest Corner of the State.

About three weeks during the months of April and May were spent in scouting for gypsy moth egg-masses in the northwest corner of the State.

In 1911 the towns of Great Barrington, Lenox and Stockbridge in Massachusetts, not far from the Connecticut State line, were found to be infested with the gypsy moth. These towns are on the main automobile roads passing through the border towns of this State, and during the summer months, when the caterpillars are active, there is much travel along these roads, with the consequent danger of the caterpillars being carried from the infested districts into Connecticut.

It was therefore deemed advisable to watch this part of the State to guard against any possible introduction of the insect, and to this end the trees in the villages, along the main roads and on many of the large estates in Salisbury, North Canaan, Norfolk, Sharon and Canaan, were examined for egg-masses, but nothing was found to indicate the presence of the gypsy moth at any of these places.

Salisbury.

In the town of Salisbury much time was spent around the village of Lakeville. There are many trees along the streets and in the yards of this village which needed careful examination. The grounds and the road approaching Hotchkiss School were also given careful attention, as automobiles frequently come to the school from all parts of New England.

The main road leading west from Lakeville was followed as far as the road leading to the south, beyond Ore Hill. The surroundings of Ore Hill village were examined and also around the mines. From Lakeville the trees along the road running east to the village of Salisbury were examined, the village itself, the roads running northward, as far as Ball Brook and the Chapinville road for a short distance beyond the railroad tracks. At Twin Lakes are many summer cottages, the owners of which come from many different sections during the summer, and consequently the trees in this vicinity were looked over with especial care.

The road running from Chapinville station north through Chapinville, as far as Hammertown, was followed and included all the territory around Scoville's estate at Chapinville. At Lime Rock the street trees and along the roads to Falls Village were looked over.

North Canaan.

In the town of North Canaan, the junction point of the C. N. E. and N. Y., N. H. & H. railroads, at Canaan village, was looked upon as a dangerous point, as it is only about a mile distant from the Massachusetts state line, and connected by electric railway and within ten miles of Great Barrington, where the gypsy moth has already been found. Careful search of the entire village and roads leading north to the state boundary failed to reveal any signs of infestation.

The main automobile road out through East Canaan was also followed to the town line, as this is the route generally taken, in traveling between the summer colonies of Lenox and Norfolk. The camp meeting grounds at Pine Grove, three miles south of Canaan, where there are many cottages in the midst of a large pine grove, was visited and gone over carefully.

Norfolk.

The entire village of Norfolk was examined and for some distance into the surrounding country. The trees around the garages and driveways of the many summer homes in this section were given special attention, as it was feared that caterpillars from some of the infested towns nearby in Massachusetts might be brought in on the numerous automobiles and other vehicles that pass back and forth between these sections during the summer months. It is at this time that the caterpillars are most active, crawling about in going from tree to tree and frequently hanging suspended over the highways. In this manner they may gain access to any passing vehicle and be carried for a long distance, either dropping off along the way or crawling out of the vehicle when it stops. The vicinity of the Music Shed, where the concerts of the Choral Union are given, was examined, as these concerts come during the months of June, and are attended by many people who come from all directions.

The automobile road leading out through West Norfolk, on the way to Canaan, was followed as far as the town line. On the south everything was looked over as far as the second railroad bridge, and on the east, as far as the group of houses around the fork of the roads, and on the north as far as the cemetery beyond Haystack Mountain.

Sharon.

The central part of the village at Sharon and also the road out through Sharon Valley to the state line, towards Millerton, N. Y., was examined.

Canaan.

In the town of Canaan the only place receiving attention was at Falls Village, where the entire village was examined, including the road leading from the village of Lime Rock and northward on the main automobile road to the village of Canaan.

The result of the work done in these towns would seem to indicate that the gypsy moth has not, as yet, spread into Connecticut at this point from the nearby infested towns in Massachusetts. The danger from this source, however, may be considered to be serious and it will be necessary to keep a close watch on this section, under the conditions now existing.

CONTROLLING THE BROWN-TAIL MOTH IN 1912.

By W. E. Britton and D. J. Caffrey.

Control measures against the brown-tail moth, *Euproctis chrysorrhœa* Linn., in the northeast corner of the State, were continued on the same plan as in the previous year (see Report for 1911, pp. 281-286). Beginning January 29th, 1912, the towns of Thompson, Woodstock, Putnam, Pomfret, Killingly, Brooklyn and adjoining portions of Union, Ashford, Plainfield, Sterling, Canterbury and parts of Lisbon and Griswold, especially around Jewett City, were scouted for the winter nests, together with the city of Willimantic, part of Norwich and the villages in the town of Stafford.

The amount of territory to be scouted made it necessary to employ two gangs for the work. Mr. J. H. Osgood of Putnam, who had been employed by the city in this work, was placed in

charge of one gang, while the other was under the direction of Mr. Caffrey.

The control work of last year has greatly diminished the number of nests, and seems to indicate that the brown-tail moth may be kept from doing serious damage in Connecticut by continuing the present method of control. The limit of territory infested was extended further southward to include the entire town of Killingly, Plainfield as far as Wauregan, Sterling as far as North Sterling, and the eastern edge of Brooklyn as far as Long Brook. Westward along the Massachusetts state line and in the towns of Woodstock and Pomfret the limit of infested territory was reduced about two miles, no nests being found beyond West Woodstock, where a single specimen was taken. Later a single nest was found in Stafford, but in this case it probably came directly from infested territory in Massachusetts.

The greater part of the nests were found along the steam or trolley roads, main highways of travel, or near the towns and villages where the lights were thickest. From many indications it seems probable that the adults are coming in from the adjoining states of Massachusetts or Rhode Island each year, either through their own efforts or are being transported by various means of travel from those two states into Connecticut.

The methods used in scouting were the same as last year. It was found impossible to cover the woodland and brush areas, but the orchards, roadsides, around dwellings, along highways of travel and the open country were very carefully examined for nests. Fruit trees situated close to a house, either in the town or country, prove to be the most likely place to find nests, while the large apple orchards and white oak trees along the roadsides also seem to be preferred by the pests, so these localities were given special attention.

The following is an account of conditions existing in the various towns:

Thompson.

In the town of Thompson the nests were found to be present in about the same localities as last year, but in some instances were greater in number. At North Grosvenordale several small pear and apple orchards near the railroad station yielded 362 nests. Just west of Grosvenordale railroad station, on the top

of the hill, 203 nests were cut from a clump of white oak trees near the roadside. One tree at this place was so badly decayed that it was necessary to cut it down, before the nests could be removed from its upper branches. In Thompson village the nests were scattered in territory around the four corners at Thompson Inn and on both sides of the road to the railroad station, to the number of thirty-one. On the estate of Norman B. Ream, nearby, where the infestation was first discovered, only four nests were found. On the farm of Howard Ingraham, half a mile north of the village, 156 nests were taken, mostly from one pear tree. At East Thompson, near the Rhode Island state line, sixty-one nests were found. At West Thompson ten nests; Mechanicsville, three; Thompson Station, two; Wilsonville, eight; Quinebaug, seven; and Quaddick, five. Scattering nests were taken throughout the entire township, except in the region around the northern end of Quaddick Reservoir,—bringing the total number for the entire town to 966 nests.

Woodstock.

The conditions in the eastern part of the town were about the same as last year, but in the western part the nests were not nearly as numerous or scattered over as large an area. One nest was found near Davis' general store, at West Woodstock, but the remaining territory westward through Woodstock Valley and Kenyonville and northward to the Massachusetts state line was free from infestation. The orchards and scattered fruit trees in the eastern part of the town required much time for inspection and many nests were found in these places. At W. H. Young's, near South Woodstock, seventy-five nests were taken; at Bastow's, near Harrisville, sixty-five nests; while all fruit trees in this section contained one or more nests, to the total of 498, around South Woodstock. Along Main street, at Woodstock Hill across from the Academy, thirty nests were found; and back of the district school, eleven more. There were very few nests between Woodstock Hill and North Woodstock, four being taken at Echo Farm of L. H. Healey and six others scattered along in as many orchards; around the village of North Woodstock, ten nests; East Woodstock, eighty-three nests, mostly near the road, leading north over the hill. At

Sprucedale, near South Woodstock, twenty-seven nests were taken from trees around the factory there. Two nests were found in the section known as "English Neighborhood," two miles west of North Woodstock, and one other nest near Muddy Pond. In the entire town, 699 nests were found. While in Woodstock, the villages of Union, North Ashford, Eastford, Ashford and Phoenixville were scouted, together with the main roads which connected them, but no infestation was found at any of these places.

Putnam.

A great decrease was noted in the number of nests on each tree in the city of Putnam. Some of the trees which were covered with nests last year had only a few this year and the conditions throughout the city in general were much improved. In the territory between the city and the Rhode Island state line, however, especially along the main automobile road to Providence, the number of nests found was greater than last year. Along Elm street, and School street, in the city, were the worst infested places, one apple tree near the railroad station having seventy-three nests, while about seventy nests were cut from the large oak trees on Oak Hill, and forty-one nests from a pear tree at the corner of Elm and Bridge streets. Up through Rhodesville in the western part of the city the nests were not very numerous, or in the region beyond Oak Hill and Main street. At the Town Farm three nests were found; near the Children's Home, at East Putnam, thirty nests; near Day Memorial Hospital, one nest; Putnam Heights and vicinity, 105 nests and a few scattering ones near the Rhode Island state line, making a total of 1,260 nests for the entire town, where 5,989 were destroyed last year.

Pomfret.

Only a small part of Pomfret was found to be infested. The territory south of the New England Division of the railroad was free from nests as was that portion west of Pomfret Center. The worst infested spot was near Prospect Hill, on the stage road from Putnam, where sixty-three nests were cut from a small apple orchard beside the road. Six more scattering nests were found along this road nearer the Putnam town line. In the back yards along Pomfret street we took five scattering nests,

one nest on an apple tree near Pomfret Academy and several more around the Clark estate. The nursery of J. H. Bowditch and Lapsley's large orchards, near the southern border of the town, were given special attention but no infestation was found in these places. A total of eighty-two nests were found in the entire town.

Killingly.

In the town of Killingly several scattered infestations were found and these seemed to be the result of adults coming in from Putnam or from an infested portion of Rhode Island. One nest was found at Williamsville near the old grist mill, one at Dayville on Lake Side Farm, one on the loop road to Quinebaug River, one in the borough of Danielson at the corner of North and Main streets; three nests on the farm of Mrs. R. A. Bartlett, three miles north of Chestnut Hill; twelve nests on the Green Hollow road, two miles south of Danielson, on three connecting farms, and two nests one mile further south on the same road, near the Plainfield town line. Six nests were found in the vicinity of South Killingly in the southeast corner of the town. A total number of twenty-seven nests in the entire town.

Brooklyn.

The infestation in Brooklyn was confined to the extreme eastern edge of the town. Twenty-eight nests were cut from a pear tree near Long Brook, two miles out from Danielson, on the main road to Brooklyn village. This pear tree was located within twenty feet of the house and the family residing therein had recently moved from the infested locality in Putnam. Along Allen Hill road, six scattered nests were found in the apple orchards connected with the farms. One other nest was found on the Brooklyn side of Wauregan village, in the southeast corner of the town, near the Catholic Church. There were no nests found in the village or in the western and northern parts of the town. A total of thirty-five nests in the entire town.

Sterling.

The town of Sterling was scouted from Killingly line as far south as the villages of Sterling and Oneco. The fact that the Providence Division of the railroad enters Connecticut through

this section made it particularly liable to infestation. One nest was found in the village of North Sterling, about two miles west of the Rhode Island line. A total of one nest in the town of Sterling.

Plainfield.

The town of Plainfield was scouted, except a section in the southeast corner of the town. The infestation was confined to the vicinity of Wauregan village, where six nests were found on the farm of Mrs. George Davis, on the hill east of the village; four nests on apple trees just below this point; two nests near the Wauregan railroad station on the road leading north, and one nest on the hill between the railroad station and the village. The villages of Moosup, Almyville, Plainfield, Plainfield Junction and Central Village were carefully scouted but no more nests were found. A total of thirteen nests for the town of Plainfield.

While in this section, the villages of Jewett City in the towns of Lisbon and Griswold, Canterbury in the town of Canterbury and the center of the city of Norwich were scouted but nothing was found.

Willimantic.

The city of Willimantic was scouted for brown-tail and gypsy moths as far as the city limits, but nothing in the nature of an infestation was found.

Stafford.

The villages in the town of Stafford were scouted for brown-tail and gypsy moths and to determine the western limit of the brown-tail infestation. One brown-tail nest was found near the Central Vermont railroad station and from the nature of its location the insect was probably brought down from infested territory in Massachusetts, through which the Central Vermont trains pass. The villages of Staffordville, Hydeville, Stafford Hollow, West Stafford and Orcuttville were carefully scouted but no other infestations were found. Total for town of Stafford, one nest.

Summary.

The result of control work against the brown-tail moth during the past season indicates that the number of nests has been

materially decreased throughout that portion of Connecticut known to be infested. The area actually infested has been slightly increased, due to finding a few nests in the adjoining towns of Brooklyn, Plainfield and Sterling, with one isolated specimen taken at Stafford. These towns, with the previous infested area, including Thompson, Woodstock, Putnam, Pomfret and Killingly, make a total of nine towns in the State where the brown-tail moth is known to be present.

The number of nests found and destroyed in each town are as follows: Thompson, 966; Woodstock, 699; Putnam, 1,260; Pomfret, 82; Killingly, 27; Brooklyn, 35; Sterling, 1; Plainfield, 13, and Stafford, 1; making a total of 3,084. Last year (1911) 7,133 nests were found in the territory infested at that time.

The Norwich Infestation.

After finishing the scouting work described above, specimens of the brown-tail moth were received on May 14th, 1912, from Mr. John E. Fanning, 31 Willow street, Norwich, Conn. On May 17th, Mr. Caffrey investigated the matter, and upon his arrival at Norwich, Mr. Fanning pointed out the places where he had observed the work of the insect.

After scouting the surroundings this infestation was found to be an isolated one, confined to a comparatively small space, about 100 yards in length, between Franklin and Chestnut streets, and a small connecting spot in two yards on Broadway, the next street to the westward.

The worst infested spot was at 170 Franklin street. Here three pear trees and one apple tree were partly defoliated. The owner of the property had been badly afflicted with the "brown-tail rash," caused by the poisonous and irritating hairs of the caterpillars, and had been forced to seek the services of a physician. The trees in the adjoining yard of D. S. Underwood were also defoliated, somewhat, the caterpillars at this time being very active and measuring about three-fourths of an inch in length. Further along, at 230 Franklin street, were a few nests on a group of eight pear trees, and caterpillars were feeding upon the foliage. At 258 Franklin street, one nest was found on a pear tree, and the caterpillars were feeding upon the trees nearby. At 89 Chestnut street, some feeding was noticed upon a pear tree.

Back of the Norwich Nickel and Brass Company's Factory, on Chestnut street, were two pear trees containing feeding caterpillars and three or four nests. At the corner of Broadway and Willow streets, on the property of Dr. W. J. Hanford, four nests were found on one pear tree, and on adjoining property, at 125 Broadway, the caterpillars from two nests were feeding on a pear tree.

Arrangements were at once made with Frank Kimball, who contracts for spraying operations in the locality, and the foliage of all the trees found to be infested with nests or caterpillars were sprayed with paste lead arsenate, five pounds to fifty gallons of water. Twenty-two trees were treated in this manner, care being taken to give them a thorough drenching with the poison. In addition to the points named above, and to the work done the previous winter, the trees along the following streets were examined for traces of the insect: Laurel Hill to top of the hill, Spruce, Talmond, Washington to the Parade Ground, Sachem, McKinley through Rockwell, Broad, Warren, Treadwell, Boswell, Cliff, Hobart, Hamlin, Central and North Main as far as Sixth, West Main to corner of Pine and Maple, Maple, Forrest, Cortot, Asylum, Pearl, Mt. Pleasant, Peck, West to first cross road, Uncas, Williams and Lafayette. An effort was made to examine a few trees in all parts of the city, as it was impossible at the time to cover the entire city systematically. The trees were in full leaf, which makes the insect difficult to detect, but no nests or signs of feeding were observed at any of the places, except where the spraying was done.

It seems probable that the brown-tail moth was in some way transported to Norwich from the towns known to be infested in the northeastern corner of the State, or possibly from the infested portion of Rhode Island.

A NEW SAWFLY PEST OF THE BLACKBERRY.

Pamphilius dentatus MacG.

By B. H. Walden.

Adult sawflies collected by the writer in a blackberry field in Hamden, near New Haven, May 24th, 1910, were sent to Professor Alexander D. MacGillivray, who pronounced them a new

species, which he has recently described in the *Canadian Entomologist,* Vol. XLIV, p. 297, as *Pamphilius dentatus.*

When the field was again visited the following season, on June 27th, many sawfly larvæ were found, and the plants showed considerable evidence of their work. A number of these larvæ were taken to the laboratory but no adults were reared. An examination of other blackberry fields in the vicinity revealed no trace of the insect. In the spring of 1912, the place was again visited. The blackberry field where this insect was discovered two years previous had been plowed, but in two other fields nearby the insect was found and was especially abundant on one short row of blackberries near the field originally infested.

Life History and Habits.

The adults appear during the latter half of May, though in 1912, which was a late season, they were first observed on June 1st, were the most numerous June 9th, and the last adults were seen on June 14th.

The eggs are deposited in rows on the under side of the leaf, normally on the lateral veins, with the axis of the egg parallel with them, as is shown on plate II. Occasionally the eggs are fastened to the veins transversely, and very rarely are deposited on the leaf surface between the veins. No eggs could be found on June 1st, but many had been deposited by June 9th. A few larvæ were found on this latter date and all eggs had apparently hatched on June 25th. From fourteen to seventeen days are required for the larvæ to reach maturity, and by July 12th all but one or two had gone into the ground, where they remain until the following spring before pupating. Soon after hatching the young larva spins a few threads, by which it gradually draws a portion of the leaf over itself, forming more or less of a tube, within which it feeds. The larva travels ventral side up on the thin web thus formed, with its back to the leaf upon which it feeds. Where several eggs are on one leaf, the larvæ hatching from them collect together in one web, as the leaf is devoured. Other leaves may be drawn in with the first web and eaten, so all that remains of the leaves are the principal veins, each covered with a thin web, in which are bits of the leaves and castings from the larvæ. See plate I.

The habits of this insect are quite similar to those of the peach sawfly, *Pamphilius persicum* MacG., an account of which was given in the report of this Station for 1907, page 285.

Description.

Egg. White, smooth and shiny; cylindrical, about twice as long as wide, ends round, sides usually straight, though occasionally slightly curved, or somewhat narrow towards the end. Average length, 1.59 mm.; average thickness, .67 mm.

Larva: *newly hatched.* General color, pearly white; head, black; the two basal joints of the antennæ, white; apical joint, black, and the remaining joints dark brown, with the front margins white. Length, 2.5 mm.; average thickness, .48 mm.; antennæ, .27 mm.; cerci, .29 mm. One larva, under observation, increased to 3.5 mm. in length before moulting, and the anal two-thirds of the body became pale green from the food consumed.

1st moult. General color, apical third, dirty yellow, remainder, pale green; head, amber-colored; eye-spots, light brown; a brown triangular spot at center of head; first segment back of head with a faint amber-colored, elongated transverse mark covering about two-thirds of the dorsal surface of the segment; anal plate with a broad, raised portion, starting near the tip, which diverges and becomes two-branched towards the base of the plate; the raised portion and edges of the plate nearly white; remainder, green; cerci with apical joint brownish. Length, 4.5 mm.

2d moult. Head, amber-colored; mouth parts, light brown; eye-spots, triangular mark on front of head and the elongated mark on first segment darker and more prominent than in preceding moulting stage; a dark median line from back of head to anal plate; markings on anal plate more strongly defined than above; cerci with apical, joint black; middle joint with base, dark; apical margin, white; basal joint, white. Length, 11 mm.; average thickness, 2 mm.

3d moult. Head, olive green. In this and the remaining moults the appearance is similar to that of the full grown larva.

Full grown larva. General color, bluish green; body, cylindrical, somewhat flattened and slightly tapering towards either end; legs, small and slender; head, from the front, nearly round,

olive green, mottled and shiny; a dark brown spot near the center of the front at the point where the frontal sutures meet; eye-spots and mouth parts, brown; antennæ, seven-jointed; basal joint, white; apical joint, black; remaining joints, brown with the front margins white; the first segment back of the head with the raised portion brown, below which is a smaller brown spot; anal plate, broadly rounded with the lateral margins raised and with a broad, raised central portion starting at the tip and diverging near its middle into two branches which extend to the base of the plate; cerci, three-jointed; basal joint, broad and about equal in length to the two remaining joints; the first and second joints, white; the last joint, slender, tapering to a point and black in color. Length of larva, 17.5-19 mm.; average thickness, 3 mm.; width of head, 1.75 mm.; base of anal plate, 2.25 mm.

The dorsal and lateral views of the larva, as well as dorsal and ventral aspect of the anal plate and the front of the head, are shown on plate III.

The pupa was not obtained.

Adult. The adult is a moderately large and striking sawfly, somewhat resembling *P. persicum,* but differing from that species in the color of the antennæ, the basal portion of which are black with the remainder white. The tibiæ of the hind legs are black. In *P. persicum* the antennæ are black to the tips and the tibiæ of the hind legs are rufous. See plate III, b.

The facial markings of the female are similar in both species, but differ considerably in the males. The males of *P. dentatus* have the entire face (declivous area) yellow, while that of *P. persicum* has the lower half and margins of eyes yellow with the remainder black.

This species was described by Professor A. D. MacGillivray in the October issue of the *Canadian Entomologist,* Vol. XLIV, page 297, 1912, as follows:

"*Pamphilius dentatus* n. sp.—Body black, with the terminal half of the antennæ, the clypeus, a dentate spot on the inner orbits extended as a parenthesis-shaped mark to the caudal aspect of the head; an emarginate spot in front of the median ocellus and an angular line behind it, a parenthesis-shaped mark at the lateral margin of the vertical furrow, the margin of the pronotum, the tegulae, the V-spot, the scutellum, the postscutellum, a spot on the humeral angle beneath the wings, the front and middle legs and the hind legs except the tibiæ, white; the abdomen

rufous beyond the basal plates; antennæ with about twenty-seven segments; supraclypeal area carinated; head depressed about the median ocellus, sparsely punctured; declivous area smooth; median lobe of mesothorax smooth, lateral lobes densely punctured and scutellum sparsely punctured; wings hyaline; veins brownish. Length 8-10 mm.

The male differs in having the entire declivous area yellow and the notum, except the scutellum and the postscutellum, black.

Habitat.—Wilbraham, Mass.; J. O. Martin, collector. Hamden, New Haven and Wallingford, Conn.; B. H. Walden, collector.

This species is near *rubi* Rohwer."

Whether or not this insect will prove a serious pest of blackberries is impossible to state at this time. Most of the feeding takes place on the lower leaves, and very few of the canes in the infested fields were completely defoliated. On the other hand the insect has spread over a considerable area in the past two seasons.

No remedies were tried against the blackberry sawfly, but should it become abundant, spraying the foliage, about the time the eggs are deposited, with lead arsenate at the rate of two pounds in fifty gallons of water, will probably control it.

The blackberry sawfly was not observed feeding on any other species of plant, though both black and red raspberries were grown adjoining one of the blackberry fields where the sawfly was found.

THE LIFE HISTORY AND HABITS OF THE WALNUT WEEVIL OR CURCULIO.

Conotrachelus juglandis, Lec.

By W. E. Britton and H. B. Kirk.

The studies herein described were undertaken for the purpose of learning the life history, habits and seasonal development of this weevil, about which little has heretofore been known, although it was described thirty-five years ago.

The senior author first became interested in this insect through Dr. Robert T. Morris, a well-known surgeon of New York City, who has a farm at Stamford, Conn., and who is an enthusiastic nut grower, and president of The Northern Nut Growers' Association. Dr. Morris has been experimenting for a number of years trying to establish the hardier varieties of commercial nut-

bearing trees, with the idea of introducing the new and interesting industry of nut-growing into the New England States.

Since the spring of 1909 this department has received a number of letters from Dr. Morris, regarding an insect which punctures the nuts of several species of walnuts, and another (a budworm) working in the new growth of the same trees. Later, we received letters stating that he had observed weevils puncturing the nuts and had found the larvæ of some insect working in the stems. In July, 1909, Dr. Morris sent specimens of this weevil, which was identified as *Conotrachelus juglandis* Lec.

It was Dr. Morris who suggested that the Station detail someone to study the walnut weevil. Realizing the importance of the subject, Mr. Kirk was engaged as an assistant with the understanding that such investigations were to be part of his work.

The field studies were made on the premises of Dr. Morris at Stamford, and of Mr. H. L. Champlain at Lyme, supplemented by observations upon such other walnut trees as could be found growing elsewhere about the State.

The general plan of these studies and the present paper are the joint work of the authors. Mr. Kirk has done most of the field work.

The authors hereby acknowledge their indebtedness to Dr. Robert T. Morris and to Mr. H. L. Champlain, who kindly placed their trees at our disposal for study and experiment; to the Bureau of Entomology for identifying specimens and furnishing records; and to many museums and entomologists throughout the country for kindly sending us records from their specimens.

Previous Knowledge of the Walnut Weevil.

In searching the literature and in corresponding with the Bureau of Entomology and with various entomologists, it was evident that little was known about the life, history and habits of this species. B. D. Walsh, the first State Entomologist of Illinois, evidently observed the walnut weevil as early as 1867, but regarded it as a "Phytophagic species" of the common plum curculio. In his first report he states*:—

"But there, actually, in my opinion, does exist a 'Phytophagic species' of the common curculio, which is uniformly one-half larger and which

* Walsh, Report on the Noxious Insects of Illinois, I, p. 86, 1868.

in the larva state feeds, not upon stone-fruit or pip-fruit, but upon green butternuts and walnuts (*Juglans*), from the former of which I bred two individuals, August 13th. Of this peculiar type of curculio I sent specimens six years ago to our great North American authority in the Order of Beetles, Dr. J. L. LeConte; and he pronounced them to be mere varieties of the plum curculio. They scarcely differ from that insect in any other perfectly constant character than size."

In a foot note on the same page he explains:—

"There is, I believe, a slight, but perfectly constant colorational character by which these two forms are distinguishable. The broad band behind the polished black humps on the wing-cases is, in the large-sized nut-inhabiting form, of a dingy white color with a few milk-white spots. In the small plum-inhabiting form, this same band is of a bright ochre-yellow color, with more or less milk-white spots, which last, however, never occupy more than one-half of the ochre-yellow band. Moreover, I am informed by Dr. Hull, that the larva of the large-sized form—with which he has long been familiar—occurs with him in hickory-nuts having their shucks marked by the characteristic crescent-slit, and that this larva 'penetrates to the kernel of the nut.' Whereas, as is well known, the larva of the small-sized form that frequents the plum, never under any circumstances penetrates to the kernel of that fruit. This difference in the habits of the two forms is certainly very remarkable."

Mr. Walsh quotes Dr. Fitch to the effect that specimens found on butternut trees are always larger than those from fruit trees, the difference in size being ascribed, by Dr. Fitch, to the greater food supply.

In 1876 the walnut weevil was described as *Conotrachelus juglandis** by Dr. J. L. LeConte. Since that date the insect has been mentioned several times in the literature, but only as breeding in the nuts. Thus, Brooks, writing in 1910,† describes and illustrates the injury to the nuts by the adults and larvæ of this insect. Dr. F. H. Chittenden, of the Bureau of Entomology, in a letter to the senior author, as late as June 10th, 1911, states:

"This species has never been given careful study to my knowledge, and I have never had an opportunity of testing any remedy against it. I am familiar with its habits, however, having studied it when at Ithaca,

* LeConte, Proc. Am. Phil. Society, Vol. XV, p. 226, 1876.

† Brooks, West Virginia Agricultural Experiment Station, Bull. 128, p. 176, 1910.

N. Y., and found that the larva develops chiefly from the nuts of the walnut."

The first intimation that the insect breeds also in walnut stems came to us from Dr. Morris, who, in July, 1909, sent to this office specimens which he had observed "apparently at work upon a young shoot of *Juglans regia.*" In July, 1911, he sent more specimens and wrote as follows:

"You speak of the injury to the fruit. That is not where the great damage is done. Eggs are laid in the leaf axils, beginning just as soon as the leaves appear. Later eggs are laid also in the stems of the leaves, and later yet in the fruit. Some of my young trees are all but ruined already. It is a terrible pest. The Japanese walnuts, *Juglans sieboldiana* and *J. cordiformis,* are their favorites, then comes the English walnuts, *J. regia.* The chief local tree for attack is the butternut, *J. cinerea.*"

In August of the same year Mr. A. B. Champlain, then an assistant in this department, discovered larvæ working in the new growth of *J. sieboldiana* at Lyme, Conn., and brought samples to the Station insectary, where he bred the adults of *Conotrachelus juglandis,* this being the first definite record of the species being bred from the stems.

Injury and Abundance.

In Connecticut the injury caused by the adults and larvæ is confined entirely to the new growth and nuts, causing the stems, in extreme cases, to be killed entirely back to the old wood and causing the nuts to fall off before maturing.

The adults do their chief damage early in the spring, making large punctures (see plate IV, a), some of which cut half way through the leaf stems and young shoots, causing them to wilt and die, and although the main injury is done by the larvæ, the adult injury would be worth considering.

The larvæ work first in the young shoots and, later, as the stems grow, in the petioles of the leaves, in the leaf stems, or, in fact, any part of the new growth large enough to accommodate the larvæ. This injury to the new shoots by the larvæ, most severe in early summer and up to the middle of June, has been so great in the plantations of Dr. Morris at Stamford and also with the trees at Lyme, as to wholly prevent the owners from

obtaining a crop of nuts. Plate IV, b, shows the injury caused by the larvæ.

Juglans sieboldiana and *J. cordiformis* seem to be the ones preferred, and we have counted as many as eight larvæ in a stem four inches long, and have seen trees where every stem was completely tunneled out. The work can be detected by the egg puncture and by the frass which is pushed out through it as the larva grows.

From what we can learn through correspondence with other entomologists and nut growers, the damage caused by this insect is far more serious in Connecticut than in most other states. The fact that it is mentioned as breeding only in the nuts, and has not previously been recorded as attacking the new growth, would lead one to believe that it has not been very abundant, nor has caused much damage in other regions where nuts are grown.

The larvæ cause considerable injury to small trees in nurseries. For instance, in a nursery at New Haven, in August, out of forty-six three-year-old trees of *Juglans sieboldiana* and *J. cordiformis,* twenty-six were infested, some of them badly, by the larvæ tunneling in the new growth. On October 10th, the junior author examined thirty-five six-year-old trees of *J. sieboldiana* in another part of this nursery. Five trees showed larval attack but most of the year's growth was short and not vigorous, and consequently not favorable for the attack of this insect. In the same nursery, there had been considerable fall feeding at the base of the leaf petioles by the newly-emerged adults, but no beetles could be found on the trees nor underneath the stones upon the ground nearby.

In a nursery at New Canaan, about the middle of September, Mr. Kirk noticed a row containing about 265 trees of *Juglans sieboldiana* on all of which the larvæ were tunneling in the new growth. An adjoining row of about the same number of *J. regia* trees was only slightly attacked, and another adjoining row containing about 400 trees of black walnut, *J. nigra,* were uninfested. Several hundred other trees of *J. sieboldiana* in another part of the same nursery were badly infested, not a single tree escaping. Here, also, was noticed the fall attacks of the adults at the base of the leaf petioles, and two adults were collected.

What appeared to be the work of this weevil was received from Litchfield July 7th, and showed the characteristic feeding punctures at the base of the leaf stem.

Life History and Habits.

This insect has only one generation each year and passes the winter in the adult stage, though we were not able to discover the exact place of hibernation.

The beetles appear usually the latter part of May, and begin at once to feed upon the stems and leaf veins. After mating, the females begin about the last week in May to lay eggs. Apparently the beetles feed throughout the egg-laying period, as both collected and bred adults died within one or two days when left in captivity without food, but when given food they lived for a month. The beetles have the habit common to most curculios of feigning death and dropping from the stems when disturbed.

The eggs are laid on both fruit and stems in irregular crescent-shaped punctures and under flaps, similar to those of the plum curculio, *C. nenuphar,* and hatch from six to twelve days later, depending probably upon weather conditions. Eggs are laid throughout the period extending from the last week in May up to the first of August. Those laid after about July 20th hatch, but do not mature, the larvæ dying in the stems, probably because of the hardening of the plant tissues. During August many dead larvæ were observed in the stems, but no living larvæ were seen after September 1st.

The young larvæ first attack the young shoots, then the base of the leaf stems, then with some species of *Juglans* the other portion of the leaf stem is injured and finally the nuts. In the stems they work mostly upwards but are found tunneling in both directions. The moults were not observed. From one to five larvæ to each nut have been observed in butternuts, where they go into the kernel but return to the shucks to complete their larval life. From four to six weeks are required for the larval development, which does not continue in the stems after September 1st.

When mature, the larvæ enter the ground about one inch below the surface, remain there about ten days, when they pupate. From sixteen to twenty days after pupating the adults emerge and, flying to the trees, eat small holes, chiefly at the base of the leaf petioles.

The feeding habits of the newly-emerged adults might easily mislead one to conclude that the beetles were ovipositing. The

first pupæ are seen about August 1st, and the last adults are seen about September 16th. Our latest record of adults which had laid eggs earlier in the season was September 7th.

Dr. Morris informs us that he had observed adults at work on the trees as early as May 7th and as late as September 5th.

Description.

Egg. The egg is oblong oval in shape and of a creamy white color and apparently with a smooth surface, but when examined, under high power, it has a finely wrinkled appearance. Length, .95 mm.; thickness, .57 mm.

Larva. The larvæ are cylindrical and legless with no prominent markings or appendages. When young they are of a dirty white color with brown heads, and when mature the body changes to a yellowish white color. Tips of mandibles black, prothoracic segment with a brown patch nearest the head, and tubercles brown. Length of full grown larva, 12 mm.; thickness, 3½ mm.

Pupa. There is no pupal cell, the pupa being entirely naked. It is of the same general form and size of the adult and of the same yellowish white color of the full grown larva. There are a few long, slender, brown hairs on the beak, thorax and ventral side of the abdomen and two on each femur, with two prominent stouter spines on the last abdominal segment.

Adult. The adult very closely resembles the plum-curculio, *C. nenuphar,* but is readily distinguished by its larger size and the more distinct, broad, whitish band on the elytra. The beak is about one-half and the thorax one-third as long as the body. The elytra have several humps and ridges which give the beetle a rough appearance. The whole is covered with short, yellowish hairs, forming the bands on the thorax and elytra. The newly-emerged specimens are distinctly brownish in tint, but after a time turn to a darker grey color. This serves to distinguish the newly-emerged from the egg-laying adults. The length of *C. juglandis* varies from .24 to .28 of an inch, while that of *nenuphar* does not exceed .22 of an inch.

This weevil was originally described by Dr. J. L. LeConte in Proceedings of the American Philosophical Society, Vol. XV, page 226, 1876, as follows:

C. juglandis n. sp.

"Dark brown, varies with black, pubescence fulvous, or dirty yellow, forming a curved bifurcated line each side of the prothorax, and a broad band behind the middle of the elytra. Beak longer than the head and prothorax, cylindrical, not stout, shining, sparsely punctured, with a broad lateral groove, and two stout, finer ones near the base. Prothorax coarsely punctured and rugose, with a very short carina before the middle, and four discoidal tubercles; broadly constricted in front. Elytra with striæ with large quadrate punctures, alternate interspaces strongly costate, the third and fifth interrupted forming on each a high crest, with a basal and sub-apical elevation. Ventral segments sparsely punctured, fifth more finely and densely. Legs somewhat annulated, thighs bidentate. Length, 7 mm.; .27 inches.

This species is closely allied to the plum weevil, *C. nenuphar,* and has been confounded with it until the present time. It is, however, much larger, the beak is longer, more slender, and less curved; the prothorax is broader and more rounded on the sides, the crest of the fifth elytral interspace is longer, almost as large as that of the third, and overlaps it far more than half its length, and, finally, the pubescence is of a nearly uniform color, so that the band of the elytra is not variegated with white. The ventral segments are much less densely punctured."

Food Plants.

From our studies and observations, it is evident that in Connecticut the walnut weevil attacks and injures the various species of *Juglans* in the following order, those at the head of the list being most seriously injured.

Juglans cordiformis,	Heartnut,	Fruit and Stems.
" *sieboldiana,*	Siebold's walnut,	" " "
" *cinerea,*	Butternut,	" " "
" *regia,*	Persian or English walnut,	" " "
" *nigra,*	Black walnut,	Stems.
" *mandshurica,*	Japanese walnut,	"

Though we have no definite records of this weevil attacking and injuring the hickories, Mr. Kirk observed punctures at the base of the leaf stems resembling closely the feeding punctures of *C. juglandis* on *Juglans.* Dr. Morris states that he has seen them on the bitternut, *Hicoria minima,* the shellbark, *H. ovata,* and the mockernut, *H. alba.* No doubt they may attack the stems of certain hickories, and the stems and nuts of practically all

species of *Juglans,* yet they seem to prefer and only injure a few species of the latter.

Experiments in Determining Life Stages and Habits.

Adults were placed in cages made of cheese cloth sewed into a cylinder-shaped bag and slipped over the new growth and tied at both ends, to determine the habits of the adults.

The weevils were collected from the neighboring trees, immediately placed in the cheese cloth cages and were examined twice or three times a week. The adults did considerable feeding before making the egg puncture, by stripping the bark on the leaf veins and stems to such an extent that we thought it advisable to try an arsenical poison to kill them before ovipositing.

The egg and pupa stages were studied in the Station insectary. The length of the egg stage was determined by cutting off the shoots immediately after eggs were laid, and taking them to the insectary, where they were kept fresh and were examined each day until the eggs hatched.

The larvæ were studied in the field in both the stems and the nuts. Stems were marked and labeled where eggs had just hatched and the cheese cloth bags were tied over the stems to trap the larvæ when they emerged, giving the length of the larval stage. Larvæ were taken from these cages and placed in cages in the insectary, where the pupa stage and time of adults emerging were determined.

The habits of the newly-emerged beetles were studied in the field.

Control Methods.

After observing the extensive feeding habits of the adults, we were able to ascertain a probable preventive in the use of lead arsenate. Several small trees were sprayed with lead arsenate, six pounds to fifty gallons, and weevils were collected and encaged on the sprayed stems.

On June 11th, three cages were made on a tree sprayed with the above proportions; two cages containing two weevils each and the other, four weevils. Check cages were made on unsprayed trees. By June 18th all the weevils were dead in the cages and no eggs were laid and all stems showed the character-

istic feeding marks of the adults. In the unsprayed cage one weevil was dead by the 18th, while the other fed and oviposited until July 9th.

At Lyme, Conn., June 21st, two other cages were made, with three weevils each, on a Japanese walnut tree in bearing, sprayed with the same proportions of lead arsenate; two eggs were laid the following day, but the weevils were found dead a week later and there were no more punctures. The trees were examined later (August 10th) with the result that no more punctures were made after the trees were sprayed, although weevil work was apparent from eggs which had been laid before the application. Four adjoining trees showed considerable weevil injury and larvæ were still working in stems and nuts, while in the tree sprayed no larvæ were found.

Several other tests were made on a black walnut tree on the Station grounds, with similar results.

In one nursery, cutting off the infested shoots in mid-summer, say about June 20th, is practiced. The tree afterwards makes a good growth and the shoots are not seriously injured by the weevils, late in the season.

This pruning must not be done too late, however, else the new growth will not ripen sufficiently and will be winter-killed.

In any spraying work to control the walnut weevil, the spray should be directed against the under surface of the leaves in order to kill as many as possible of the adults which feed there on the leaf veins.

Distribution in North America.

Apparently this weevil occurs at least throughout the eastern half of the United States and Canada, though in a large portion of this territory it is not abundant and is not considered an important pest. In order to obtain definite records of its occurrence some sixty letters were sent to specialists, station and museum entomologists, horticulturists and nut growers, asking for the records on the specimens in their collections and for the results of their field observations regarding this insect. About fifty-one replies were received, from which the following records of distribution are compiled. The names given are in most cases not those of the collector, but of those reporting the records to us.

ALABAMA: Andalusia (Bur. Ent. coll., Wash., D. C., A. L. Quaintance).

CANADA: Belleville, Ont. (coll. of J. D. Evans, Trenton, Ont.).
Hamilton, Ont., Ridgeway, Ont. (Ont. Agr. College coll., Guelph, Ont., C. J. S. Bethune).
Montreal (Colo. Expt. Sta. coll., Ft. Collins, Colo., C. P. Gillette).
Mount St. Hilaire, Mont. (coll. G. Chagnon).
Ontario (Am. Mus. Nat. Hist. coll., N. Y. City, C. W. Leng).
Ottawa (coll. of W. H. Harrington, Ottawa, Can., A. Gibson).
Ridgeway, Ont. (coll. of J. D. Evans, Trenton, Ont.).
Laval County (Can. Dept. Agr. coll., Ottawa, Can., A. Gibson).
Toronto, Ont. (Cornell Univ. coll., Ithaca, N. Y., G. W. Herrick).

CONNECTICUT: Lyme (coll. of A. B. Champlain, Harrisburg, Pa.).
Lyme (Conn. Expt. Sta. coll., New Haven, Conn.; collected by A. B. Champlain and H. B. Kirk).
New Canaan (Conn. Expt. Sta. coll.; collected by B. H. Walden).
North Branford (Conn. Expt. Sta. coll.; collected by H. B. Kirk).
Stamford (Am. Mus. Nat. Hist. coll., N. Y. City, C. W. Leng).
Stamford (Bur. Ent. coll., Wash., D. C., A. L. Quaintance).
Stamford (Conn. Expt. Sta. coll.; collected by H. B. Kirk).
Stamford (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).

DISTRICT OF COLUMBIA: Washington (U. S. Nat. Mus. coll., E. A. Schwarz. Listed by Ulke).
Washington (Ohio State Univ. coll., Columbus, O., H. Osborn).

GEORGIA: Clayton (Am. Mus. Nat. Hist. coll., N. Y. City, C. W. Leng).
Santa Catherina Island (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).

ILLINOIS: Galesburg (Am. Mus. Nat. Hist. coll., N. Y. City, C. W. Leng).
Central Illinois (observed by H. Garman).
Northern Illinois (Ill. Expt. Sta. coll., Urbana, Ill., C. A. Hart).
Illinois (mentioned by B. D. Walsh).

INDIANA: Elkhart (Mich. Expt. Sta. coll., East Lansing, G. D. Shafer).
Harrison County (Ind. Expt. Sta. coll., Lafayette, Ind., J. Troop).
Posey County (Ind. Expt. Sta. coll., Lafayette, Ind., J. Troop).
Southern Indiana (Ind. Expt. Sta. coll., Lafayette, Ind., J. Troop).

IOWA: Guttenberg (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).
Iowa (Mus. Comp. Zool. coll., Cambridge, Mass., S. Henshaw).

KANSAS: Douglas County (Univ. of Kan. coll., Lawrence, Kan., S. J. Hunter).

LOUISIANA: Mound (Bur. Ent. coll., Wash., D. C., A. L. Quaintance).

MARYLAND: Plummer's Island (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).
Maryland (Minn. Expt. Sta. coll., St. Anthony Park, Minn., A. G. Ruggles).

MASSACHUSETTS: Mass. (coll. of H. C. Fall, Pasadena, Cal.).

NEBRASKA: (Indications but no definite record, L. Bruner).

NEW JERSEY: Newark (N. J. Expt. Sta. coll., New Brunswick, N. J., H. B. Weiss).
Orange Mts. (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).
South Orange (Am. Mus. Nat. Hist. coll., N. Y. City, C. W. Leng).
New Jersey (Mus. Comp. Zool. coll., Cambridge, Mass., S. Henshaw).

NEW YORK: Buffalo (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).
Buffalo (Univ. of Kan. coll., Lawrence, Kan., S. J. Hunter).
Ft. Montgomery (Am. Mus. Nat. Hist. coll., N. Y. City, C. W. Leng).
Newport (New York State Mus. coll., Albany, D. B. Young).
New York City (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).
*New York City (Bur. Ent. coll., Wash., D. C., A. L. Quaintance).
Peekskill (Cornell Expt. Sta. coll., Ithaca, N. Y., G. W. Herrick).
Phoenicia (N. Y. State Mus. coll., Albany, N. Y., D. B. Young).
Poughkeepsie (N. Y. State Mus. coll., Albany, N. Y., D. B. Young).
Westchester (Injury observed by W. C. Deming).
New York (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).
New York (Am. Ent. Soc. coll., Phila., Pa., H. Skinner).
New York (coll. of H. C. Fall, Pasadena, Cal.).
New York (Mich. Expt. Sta. coll., East Lansing, G. D. Shafer).

NORTH CAROLINA: Magnetic City (Bur. Ent. coll., Wash., D. C., A. L. Quaintance).
Round Knob (U. S. Nat. Mus. coll., Wash., D. C., W. D. Pierce).
North Carolina (Mich. Expt. Sta. coll., East Lansing, G. D. Shafer).

OHIO: Cincinnati (Am. Mus. Nat. Hist. coll., N. Y. City, C. W. Leng).
Sugar Grove (Expt. Sta. coll., Wooster, O., H. A. Gossard).

PENNSYLVANIA: Allegheny (Ill. Expt. Sta. coll., Urbana, Ill., C. A. Hart).
Allegheny (Mus. Comp. Zool. coll., Cambridge, Mass., S. Henshaw).
Allegheny (Am. Mus. Nat. Hist. coll., N. Y. City, C. W. Leng).
Bethlehem (Lab. Econ. Zool. coll., Harrisburg, Pa., A. B. Champlain).
Harrisburg (Lab. Econ. Zool. coll., Harrisburg, Pa., A. B. Champlain).
Jeanette (reported by Mr. Klages).
Pittsburg (reported by Mr. Klages).
Pottstown (Wagner Inst. coll., Phila., Pa., A. B. Champlain).
Winewood (Bur. Ent. coll., Wash., D. C., A. L. Quaintance).
Dauphin County (reported by Dr. Castle).
Lancaster County (reported by Dr. Castle).
Penn., Southwestern (reported by Dr. John Hamilton).
Penn. (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).

TEXAS: Texas (Mich. Expt. Sta. coll., East Lansing, Mich., G. D. Shafer).

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*These specimens were collected by Dr. R. T. Morris and may have been taken on his farm at Stamford, Conn.

VERMONT: Burlington (Boston Soc. Nat. Hist. coll., Boston, Mass., C. W. Johnson).
VIRGINIA: Hume (Bur. Ent. coll., Wash., D. C., A. L. Quaintance).
Pennington Gap (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).
Petersburg (Bur. Ent. coll., Wash., D. C., A. L. Quaintance).
Virginia, Southwestern (observed by W. J. Price).
Virginia (Am. Ent. Soc. coll., Phila., Pa., H. Skinner).
WEST VIRGINIA: Berkeley (U. S. Nat. Mus. coll., Wash., D. C., E. A. Schwarz).
French Creek (Expt. Sta. coll., Morgantown, W. Va., W. E. Rumsey).
WISCONSIN: Wis. (N. Y. Expt. Sta. coll., Geneva, N. Y., P. J. Parrott).
Wis. (Mus. Comp. Zool. coll., Cambridge, Mass., S. Henshaw).

Many experiment station collections contain no specimens of the walnut weevil. A few have material from their own state. Others have specimens from adjacent or distant states, and the existence of such specimens is frequently unknown to the entomologists now working in the states where the beetles were collected. We mention this to show that in all probability this weevil is not as abundant throughout the range of *Juglans* as in Connecticut, or it would have been collected more extensively, and had it caused much damage it would probably have been studied elsewhere.

Several entomologists and collectors report no records for their states, but such data were furnished by others.

Reports were received from Professors A. J. Cook, R. W. Doane, and H. C. Fall, California; Professor C. P. Gillette, Colorado; Professor C. O. Houghton, Delaware; Dr. E. W. Berger and Professor J. R. Watson, Florida; Professor J. M. Aldrich, Idaho; Professor H. Garman, Kentucky; Dr. Edith M. Patch, Maine; Geo. D. Shafer, Michigan; A. G. Ruggles, Minnesota; Professor Leonard Haseman, Missouri; Professor R. A. Cooley, Montana; Professor W. C. O'Kane, New Hampshire; Professor C. E. Sanborn, Oklahoma; Professor A. B. Cordley, Oregon, and Professor A. L. Melander, Washington; but there are no records or observations to indicate that *Conotrachelus juglandis* occurs in these states. No reports have been received from Arizona, Arkansas, Mississippi, Nevada, New Mexico, North Dakota, Rhode Island, South Carolina, South Dakota, Tennessee, Utah and Wyoming.

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THE WALNUT BUD-MOTH.

Acrobasis caryæ Grote?

By H. B. KIRK.

While studying the walnut weevil on the plantation of Dr. Robert T. Morris at Stamford (see page 240) nests of lepidopterous larvæ were noticed on the tips of the branches of Persian walnut, *Juglans regia,* trees. Closer examination revealed larvæ tunneling in the buds and new shoots and causing about as much damage as the weevil itself.

This insect was observed more than three years ago by Dr. Morris, who wrote in July, 1909, as follows:

"By the way, I will enclose some newly discovered bud-worm work and of very serious character, as it comes at a season when my men are not looking out for bud-worms. I send under separate cover three shoots from a young *Juglans regia* (the only shoots which it had) all headed off by the bud-worm. In May the bud-worms badly injured *Juglans cordiformis, J. sieboldiana, J. australis, J. mandshurica, J. regia, J. nigra, J. rupestris,* and *J. Californica:* also *Hicoria ovata, H. laciniosa,*

H. persa and several hybrids. They are particularly fond of *J. cordiformis*. Some trees of this species five years old and about ten feet high had practically every terminal bud infested this spring."

A month later Dr. Morris wrote:

"Under separate cover I am sending specimens of *Juglans cordiformis* showing work of a new lot of bud-worms. This makes the third brood apparently for this season, if all are of the same species. Bud-worms are going to do terrible damage among my thousands of young nut trees."

In 1911 Dr. Morris regarded the bud-worms as the larvæ of the walnut weevil, *Conotrachelus juglandis*, therefore his statement regarding damage should be modified, as some of the injury to the various species of walnut and hickory about which he wrote in 1909 was undoubtedly caused by the weevil instead of the bud-worm. In the studies herein described, the Persian walnut, *J. regia*, was more seriously injured than any other species observed.

Extent of Injury.

The damage done by this insect, shown on plate VIII, is fully as great as that of the weevil itself, and although there are not as many species of trees affected, the most valuable species, *J. regia*, is the one preferred. In our observations on Dr. Morris' farm the damage to the above species of walnut has been greater than that of *C. juglandis*, and in a number of cases has killed the young trees in a very short time.

The young butternuts, black walnuts and several varieties of the English or Persian walnuts, *J. regia*, were also damaged seriously. On one tree, two feet high, thirty-five pupæ were found in the nests. This tree and several others not so badly infested were killed. So far as can be determined, it does not attack, or at least does not seriously injure, any of the other species of *Juglans*.

This insect has been studied and observed only at Stamford, though indications of its presence were noticed late in the season at New Canaan.

Habits and Life History.

There are at least three generations each season. The eggs are laid singly around the base of the bud and sometimes on the

leaves, are not concealed and, though small, can easily be detected on infested trees. The first brood was not discovered until in the pupa stage, when an idea of the damage was first brought to our attention.

Adults that were bred June 28th from these pupæ laid eggs two days later. These eggs hatched in from six to ten days. Calculating from the period necessary for the development of the second brood, the first eggs are laid about the second week in May. Eggs of the third brood are laid about August 15th to 22d. When the larvæ of the third brood were first discovered (August 23d) they were about an eighth of an inch in length, and when examined September 7th, they were found in the old nests of the previous brood and apparently had not increased in size. No observations were made after this date, but the young larvæ probably pass the winter in the old nests.

The larval habits of this insect are quite varied, feeding on the buds, leaves, and stems. The stem-feeding habit is most peculiar; sometimes the feeding is from the outside and only on one side of the stem, while again the larva begins on the terminal or an axillary bud and commences feeding downward, being entirely concealed all the while.

On account of this latter habit the work of this species and that of the walnut weevil was at first thought to be caused by one species of insect. But even with this similarity, the work of the two species can readily be distinguished. The larva of the walnut weevil exudes its frass by pushing it out from the egg punctures at the base of the petioles or along the stem, but never at the terminal end of the new shoot. In the work of the present species the tips of the shoots die and the frass is retained and afterward forms a part of the pupal case, and again the nests are always apparent with the frass and leaves drawn together where the majority of the pupal cases are found.

The nest, which is the most conspicuous evidence of the presence of this insect, contains most of the pupæ. The remaining few are found in the dried tips of the stems or in the green stem itself. From two to three weeks after pupating the adults emerge.

Adults, bred in the laboratory, laid eggs several days after emerging and died shortly after. The egg and adult stages of this insect are shown on plate IX.

Identity of the Bud-Moth.

Several fresh-reared adults were submitted to Mr. Charles R. Ely of Washington, D. C., a specialist in this group. Mr. Ely, on first examination, considered this a new species, and remarked that, according to his memory, the pupa cases were quite different from those of *Acrobasis caryæ* Grote, to which the adults bore a close resemblance. It is recognized that in the genus *Acrobasis* adults of certain species can be separated only by a knowledge of the food habits of their larvæ.

Mr. Ely afterward examined the material in the U. S. National Museum and, in company with Dr. H. G. Dyar, compared our specimens with those labeled *A. caryæ* Grote in the collections. They seemed to be identical. Mr. Ely states, however, that the specimens in the museum are not really proved specimens of *A. caryæ* as their larval habits are not known, and furthermore that the adults appear different from the others which were bred from pecan. For the present, therefore, we must refer to this bud-worm of the walnut as *A. caryæ* Grote, but on further investigation it may prove to be an undescribed species.

Description.

Egg. Irregularly oval, greenish white, surface finely wrinkled, .57 mm. long and .34 mm. wide.

Larva. The larva is cylindrical, tapering slightly toward both ends, and is sparsely covered with long hairs. There are no prominent markings; tubercles indistinct. Mouth parts and body of a dirty olive green color, head shining black and on the dorsal side of the first segment is a black patch with a smaller black spot on either side, the larger patch being divided in the middle by a line the same color as the body. Second segment marked with two small black dots; legs in front, black. Length, five-eighths of an inch; thickness, one-eighth of an inch.

Pupa. About seven-sixteenths of an inch in length, distinctly tapering. Light brown in color with no striking markings. Anal extremity with a short, sharp spine on either side pointing outward and four slender hooked spines at posterior end. Abdominal segments finely and moderately densely punctured.

The pupa is enclosed in a cylindrical-shaped case about one-half inch long and about three-sixteenths of an inch in diameter.

It is composed chiefly of frass of the larva. Sometimes a number of cases are welded together in one mass, but the general shape is the same.

Adult. The adult is a grey moth having a wing-expanse of about three-fourths of an inch but showing much variation in size. The primaries are ash-grey or darker, with lighter basal areas and a light grey suffused area on distal third of front margin extending scarcely half-way across the wings, more or less iridescent. Secondaries unicolorous and in most cases lighter than the primaries.

Acrobasis caryæ, which is probably identical with the walnut bud-moth, was originally described by A. R. Grote in *Papilio,* Vol. I, page 13, February, 1881. The description is reprinted here, and is as follows:

Acrobasis caryæ n. s.

"Male. The maxillary palpi untufted, the antennæ ciliate, with a sub-basal flexure and a scale-tooth on the thickly scaled basal joint. Shining grayish fuscous; the head and thorax concolorous. Smaller than *Angusella,* without the carneous shadings and reddish thorax and head. Outer line of primaries pale, narrow and faint. Inner line a ridge of raised darker scales narrowly edged outwardly by a pale, flesh-colored shade. The wing is paler, more grayish, at base. The color shifts with the light. Discal points faint. In ornamentation this species is inconspicuous. Hind wings, as usual, blackish; fringes interlined, concolorous. Length of primary wing, 9 mil. Reared by Mr. Coquillett from larvæ on *Carya porcina;* the larva has been found 'boring into the twigs.'"

Mr. Coquillett describes the larva and chrysalis as follows:

"Body subcylindrical, smooth, pale greenish ash; a pale brown subdorsal dot on each side of segment 2; a wavy-fold below the spiracles; the latter are encircled with a dark brown ring, and there is a brown piliferous dot above each; a few whitish hairs on each side of the body; top of segment 1 polished, yellowish green; head narrower than segment 1, heart-shaped, dark brown; venter pale green, unmarked; 16 legs; length 14 mm. Found May 21, burrowing in the branches of the pignut hickory, *Carya porcina,* usually selecting the lower branches; imagoes about June 22.

Chrysalis. Of the usual form, pale brown, rounded at the posterior end, at which place there is a cluster of about four slender hooked spines; length, from 7 to 8 mm. The larva spins a thin web around the footstalks of the leaves which grow near the terminal end of the branch, and then burrows into the terminal bud and the wood of the present year's growth. It webs its castings together and forms a short

tube which projects outward from the mouth of its burrow, and is closed at the outer end. The larva probably assumes the chrysalis form in its burrow, but those which I reared deserted their burrows and spun tough cocoons beneath the litter in the bottom of the breeding-cage. These larvæ are very subject to the attacks of parasites; from a small number which I collected I obtained three moths and two Hymenopterous parasites which Mr. E. T. Cresson determined to be the *Phanerotoma tibialis* of Haldeman. One of these parasites issued June 21 and the other June 26."

Natural Enemies.

Two Tachinid flies were reared from the second brood of larvæ, emerging August 1st. These have been determined by Mr. Harrison E. Smith of the Bureau of Entomology as *Exorista pyste* Walk.

Remedies.

The larvæ feed mostly on the leaves which are drawn into the nest and this pest can therefore be easily controlled by an arsenical spray applied to the foliage. On the trees sprayed with lead arsenate (six pounds in fifty gallons of water) for the adults of the walnut weevil no bud-worm injury was noticed. Most all of Dr. Morris' trees, especially the Persian or English walnut, were infested with both the weevil and the bud-moth, so that both insects could be controlled with the same applications. The larvæ of the three broods appeared this season about June 1st, July 10th and August 18th. The weevil is most abundant after June 1st, so if applications are made on the first two dates the bud-moth would be controlled and a large percentage of the weevils destroyed. However, if the weevils are abundant, a second application should be made two weeks after the first. Further trials are necessary to establish practical control methods for this insect, but it is probable that less poison, perhaps three pounds in fifty gallons of water, may prove effective against the bud-moth as well as against the walnut weevil.

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THE MOSQUITO PLAGUE OF THE CONNECTICUT COAST REGION AND HOW TO CONTROL IT.*

The salt marshes along the coast furnish the principal part of the mosquito plague of the southern portion of the State. Contrary to the habits of most mosquitoes, those of the salt marsh species fly inland long distances, and as they are large and very abundant, and are voracious feeders, they make life a burden to many inhabitants, and keep away many others who would otherwise summer on the Connecticut coast. This condition results in preventing the proper development of a legitimate business and the people of the State are so much the poorer on account of it. That the remedy is not impossible, nor impracticable, nor so expensive as most people suppose, and that for agricultural purposes the land is greatly improved by the treatment, the details given on the following pages will show:—

MOSQUITOES OF THE SALT MARSH.

There are two species of mosquitoes which breed abundantly on the salt marshes and which are commonly called salt marsh mosquitoes—the brown salt marsh mosquito *Culex cantator* Coq. and the banded salt marsh mosquito *Culex sollicitans* Walk.

THE BROWN SALT MARSH MOSQUITO.

The brown salt marsh mosquito *Culex cantator* Coq. is large and uniformly reddish brown in color without conspicuous markings, though there are narrow white bands on the legs and on the abdomen. It is shown in figure 1. Breeding upon the salt marsh early in the season, the females bite fiercely and migrate long distances in search of food, going chiefly inland, which in Connecticut is the direction of the prevailing winds. About July 1st, it is almost or wholly replaced by the banded salt marsh mosquito, which is present during the remainder of the season.

THE BANDED SALT MARSH MOSQUITO.

On account of its white markings this is the most conspicuous mosquito of medium size found in Connecticut. All of the legs are banded, dark and white alternating, and the front margin of each abdominal segment is also white and there is a dorsal longitudinal white line on the abdomen. In addition to these striking

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characters there is a white band upon the beak, about half way between base and tip, and these markings together serve to distinguish this from all other species of mosquitoes.

The eggs are laid on the mud of the salt marsh pools and hatch when the pools fill with water. About a week is required in warm weather from the hatching of the egg to the emergence of the adult mosquitoes, which come in swarms or broods and

FIG. 1.—The brown salt marsh mosquito, *Culex cantator* Coq.: 1. adult female: 2. palpus; 3. anterior claw of same; 4. 5. 6. anterior, median and posterior claws of male. All enlarged. (After Smith, Report on New Jersey Mosquitoes.)

are often extremely abundant, and the females bite ravenously. They migrate inland in search of food, sometimes going twenty-five or thirty miles. It seems to be necessary for the females to obtain blood from one of the higher animals in order to develop their eggs. Most of them are probably able to obtain food within from five to ten miles of their breeding places.

The banded salt marsh mosquito is far more abundant than the brown salt marsh species, and appearing later in the summer, constitutes the mosquito plague of the shore region, remaining

until cool weather prevents further mosquito breeding. This mosquito is the one commonly called the salt marsh mosquito and is shown in figure 2.

Of course there are several species of fresh water mosquitoes of the genus *Culex,* and malarial mosquitoes, *Anopheles,* breeding in the fresh water pools in the rear of nearly every salt water marsh, and rain barrel mosquitoes breed in the cisterns and

FIG. 2.—The banded salt marsh mosquito, *Culex sollicitans* Walk.: 1. adult female; 2. palpus: 3. anterior, 4. median and 5. posterior claws of male. All enlarged. (After Smith, Report on New Jersey Mosquitoes.)

other receptacles around the shore cottages, but these are local and do not fly far. They do not as a rule breed in salt or brackish water, and do not constitute any important part of the mosquito plague of the Connecticut coast region.

AREA OF SALT MARSH IN CONNECTICUT.

The salt or tide water marshes of Connecticut contain 22,264 acres or 34.79 square miles,* distributed rather unevenly, along

* D. M. Nesbit, Miscellaneous Special Report No. 7. The Marshes of the United States, U. S. Department of Agriculture, 1884.

the coast in the southern part of the State. The marsh areas are the most extensive in the middle part of the coastal region, or that portion bounded on the west by the Saugatuck and on the east by the Connecticut rivers. A considerable portion of the coast is hard land, being gravelly or rocky and there are few large tidal marshes, the largest in the whole state being the Quinnipiac marsh, near New Haven, of over 3,000 acres in extent.

CONDITION OF THE SALT MARSH AREAS.

In the report of the Mosquito Survey of Connecticut, made in 1904, and published in the report of this station for that year, page 285, it was stated that fully 50 per cent. of the entire salt marsh area of the State had at some time been thoroughly drained for salt hay farming. Other portions are well drained naturally, and so are not serious breeders of mosquitoes.

In recent years, however, salt hay farming seems to have been neglected, though it is hard to understand why: as the hay still brings a price ranging from $7 to $12.00 per ton, and there is quite a demand for it for packing, bedding and mulching material. Many salt marshes have been neglected, the old ditches have become clogged, filled or grown up and few new ones have been run. Such marshes are prolific breeding places of salt marsh mosquitoes. From personal observations, and from conversation with some of the older residents, we may safely conclude that in many cases at least the marshes are in worse condition to-day than they were thirty or forty years ago and mosquitoes correspondingly more numerous. Wherever the marsh becomes sufficiently congested, water stands, the turf rots and a depression is formed which increases in size and breeds millions of mosquitoes.

Nearly every salt marsh receives more or less fresh water from springs or streams emerging from the highland. This water must pass through the marsh to reach the ocean. Some marshes are so congested that the fresh water cannot drain off but is sent back, making soft bogs with considerable stagnant water. Often the highest and driest part of the salt marsh is near the inlet, while the lowest portion is at the back side next to the highland. In such places, and often nowhere else upon the marsh, stagnant water occurs.

Many persons think that if tide gates are provided, it will prevent mosquito breeding, and that no other work is necessary. But the gates keep out only tide water. Fresh water enters just the same and must be allowed to pass out. Hence drains are necessary. Tide gates only prevent the flooding of the marsh at high tide and are almost negligible so far as mosquito breeding is concerned. It is necessary to do almost as much draining with as without a tide gate. Wherever the tide rises and falls in the ditches, mosquitoes will not breed.

Tide gates are of much value in salt hay farming, for they keep the marshes from becoming flooded at each perigee tide and prevent the salt grass from becoming encrusted with salt. Hay is considerably more valuable and a much greater yield is obtained if the salt water is not allowed to flood the marshes during the growing period.

Some communities, however, have recently made a start toward improving the conditions of the marshes. Nearly seven miles of coast marsh land was drained in 1911, just east of Stamford, and the present season similar work is being done about Greenwich, Fairfield, New Haven, Branford and Saybrook. This draining has all been for the purpose of doing away with mosquitoes, and not for increasing the yield of grass; yet the latter result is gained.

MOSQUITO CONTROL.

The general methods of mosquito control are (1) draining of the marshes, (2) oiling the breeding pools and (3) screening of rain water receptacles. The first, or draining, is the method to be chiefly considered in connection with the present control of the mosquito nuisance; the second may be employed temporarily until the draining can be carried out, and the third should receive attention each year.

METHODS OF DRAINING.

Where there is a natural stream flowing through the center of the marsh, the area may be satisfactorily drained by running simple lateral ditches running nearly at right angles to the axis of the stream, with the outlets bearing slightly toward its mouth.

These lateral ditches should be narrow—not more than ten inches wide—and from 24 to 30 inches deep, according to the character and size of the area to be drained. If there is no stream for an outlet, then a broad central ditch must be cut. This should be fully as deep as the laterals and wide enough to carry off the water supplied by them. The lateral ditches should be parallel with each other and from one hundred to one hundred and fifty feet apart, according to the condition of the marsh. It is not necessary to connect each pool with the tide water in ditching, as the seepage is so great through the porous peat of the salt marshes that pools are often drained and become dry at a distance of sixty or more feet from the ditch.

In draining some Connecticut marshes clay or gravel is encountered in the bottom of the ditch. It is not necessary to cut into this material unless it is near the central ditch where it will trap the water.

Ditches cut years ago for salt hay farming were shallow and open. Such ditches are not recommended and are not being cut at the present time in mosquito extermination drainage work. Shallow and open ditches are easily clogged by floating *debris* and vegetation grows in them readily, choking them and rendering them ineffective. Deep narrow ditches, on the other hand, remain in working condition for a number of years and are seldom clogged by vegetation. All marsh areas should be given attention, however, because in high tides, sods from the ditches, hay, driftwood or other *debris* may float into the ditches and clog them. By a frequent and systematic patrol of the area such conditions may be detected and remedied at once.

Such ditches as are mentioned above can best be cut with hand tools made for the purpose, shown on Plate XI, but on the larger marsh areas of New Jersey power machines may be employed to advantage.

There are always small depressions which should be filled and can be filled easier and cheaper than they could be drained. This is particularly true in the hard land. There are also certain depressions where on account of the expense draining is impracticable. These may be treated by dredging out the center and filling the banks with the material excavated, thus concentrating the water in a permanent pool which should be stocked with fish.

COST OF DRAINING MARSH LAND.

The cost of draining salt marsh land is not prohibitive. In fact it is actually less than most persons expect. From contracts which have been made recently for such work, and from conversing with the contractors, we may state that the salt marshes of Connecticut may be drained, so that they will not breed mosquitoes, at a cost of between $5.00 and $10.00 per acre, or say an average of not over $8.00 per acre. As this area contains 22,264 acres the cost of draining the salt marshes of the whole State would not exceed $178,112.00, a sum insignificant considering the benefit to be derived from its judicious expenditure.

Some contracting firms are prepared to drain marsh areas at a given price per running foot of ditch, the price varying from two cents upward, according to the amount and character of the work to be done.

On some of the large marsh areas of New Jersey, ditches have been cut by power machines at a price as low as one cent per running foot of ditch, and contracts have been made for draining certain definite areas at less than $2.00 per acre.

RESULTS OF DRAINING SALT MARSH.

Wherever salt marsh is properly drained the land rises perceptibly, becomes much harder than before and there is no stagnant water upon it; mosquitoes cannot breed thereon, and consequently all land in the vicinity of the marsh becomes more desirable for residence purposes. If depressions occur and fill with water at flood tide, it will soon seep away before mosquitoes can develop in it. As the land becomes firmer it is easier to get over it, especially with a team, for cutting and removing the salt hay. The character of the vegetation soon changes and the spike grass *Distichlis maritima,* which is characteristic of breeding areas and which always produces a small yield of poor quality hay, gives way to black grass *Juncus gerardi,* which makes the best salt hay and which all over the marsh gives a much greater yield after draining. During the summer a practiced eye can tell at a glance, by the color of the marsh, which portions of it are well drained, showing the bright green of the black grass, contrasting with duller green or gray of the spike grass and the other marsh vegetation of the ill-drained areas.

The yield is often increased three or four fold by simple draining, and land has been known to produce twenty times as much after the operation.*

Such an increase in yield might, even with the crop of a single season, more than pay the cost of draining. But this increase keeps up as long as the drains work and the total increase in yield and quality of the crop is enormous.

This yield, of course, greatly increases the income from the land, which accordingly increases in value as an investment. Surrounding property also becomes more valuable on account of the increase in the value of the marsh.

That the growing of vegetable crops on the salt marsh, where properly drained and dyked, is not impossible, nor impracticable, was demonstrated a few years ago by Mr. F. R. Sammis of Stratford, who grew some excellent celery, asparagus and onions on the big Stratford marsh. In future years, unquestionably some of our salt marsh land will be used to grow such crops.

But more particularly on account of getting rid of the mosquito plague is the benefit felt by those living near the marsh. The people are more healthy and more comfortable. Shore resorts, summer hotels and cottages, as well as permanent residences, all benefit by such improvement work. If the mosquitoes can be eliminated from the coast region of Connecticut—and they will be if we drain the marsh land—there is no more attractive place in the country where one can spend the summer. Last but not least, the railroad and transportation companies will reap a harvest in the increased summer traffic to and from the shore resorts.

OILING OF BREEDING POOLS.

Where mosquito larvæ wrigglers are found in any pool, they may be killed in a few minutes by spreading a film of oil over the surface of the water. It is necessary for the larvæ to come to the surface about once each two minutes to breathe, and the oil not only prevents the air from entering their respiratory system, but the oil also enters their breathing tubes, destroying the tissues, and they soon die.

The oil must be applied about once each ten days to keep the

* J. B. Smith, Bulletin 207, New Jersey Agricultural Experiment Station 1907.

pool in a safe non-breeding condition. For this purpose ordinary kerosene, which can be purchased from any grocer, will answer. Some prefer a heavier oil, called light fuel oil. One grade sold by the Standard Oil Co. as "34° Distillate" has been recommended for this work.

Oiling at its best is but a temporary expedient, and should be practiced on the salt marsh only until the marsh can be drained. In mid summer the tall vegetation often obscures many small breeding places, and likewise makes it difficult to distribute the oil on the surface of the water, where needed,—most of it striking the vegetation.

A convenient method of applying oil is by means of small compressed air sprayers with cylinders of galvanized sheet iron. Each cylinder contains a pressure pump and will hold about two and one half gallons of liquid. It may be carried in the hand or held by a strap thrown over the shoulder. Such an outfit, including short piece of hose with nozzle, may be purchased for $4.50. A two-foot extension rod is almost a necessity and costs thirty-five cents extra.

Where large areas are to be treated, barrels of oil should be distributed at various convenient points, in or around the marsh.

The amount of oil to be applied is one fluid ounce to each fifteen square feet of water surface. A less quantity will often fail to kill the wrigglers.

SCREENING OF RAIN WATER RECEPTACLES.

Many shore cottages are not connected with the water supply of the villages or cities, but rain water is collected from their roofs and conducted into barrels or cisterns, from which it may be drawn as needed. Where these barrels or cisterns are above ground and uncovered, *Culex pipiens* will certainly breed in them. Such receptacles should always be screened, and if it is necessary to take water from the top of the barrel, mosquito netting tacked upon a hoop, somewhat larger than the top of the barrel, can be placed over it and removed at pleasure, and mosquitoes cannot reach the water to lay their eggs.

Tin cans, kettles, broken bottles, clogged gutters and other receptacles on the dump or scattered promiscuously, are prolific breeding places wherever they contain water for a week or more and should never be tolerated.

COMMUNITY EFFORT IN MOSQUITO CONTROL.

In any work directed toward the control of mosquitoes in the salt marsh region, little will be accomplished except through coöperation. If one marsh is drained, some relief will be felt by those residing near it and especially on the inland side of it. But in order to really do away with the mosquito nuisance, all salt marsh areas for a distance of several miles should be drained. In the absence of State legislation, this can be done only through community effort, as the separate property owners will not as a rule coöperate effectively to such an extent, and many of them will not expend a dollar for such improvement work on their own land. If money is raised by subscription and enough procured, then large areas, beginning with the worst ones, can be treated and relief obtained.

Lower prices for draining work will be obtained through coöperation than could possibly result if each owner arranged by himself for having it done.

LEGISLATION NEEDED.

Though much can be accomplished through the coöperation of adjacent communities in treating salt marshes for the purpose of controlling mosquitoes, in order to gain the greatest benefits to all concerned, some state-wide movement should be inaugurated. Authority to drain marshes whether the owner desires it or not, should be conferred upon some officer or commission, especially where it benefits the whole community, the town and the state, without injuring the property or working any hardship to its owner.

Just what arrangement would be best has not been determined, but if the State could bear a part of the expense—perhaps one-half, and give the work proper supervision and insist on its maintenance—and the remaining portion be met by the town and the owner, each paying a certain definite percentage, in just proportion to the benefits received, it would seem to be the most desirable solution of the problem.

The salt marshes are owned by a large number of freeholders, some of whom are non-residents. Most of the owners, if they can be found, are willing to have their lands drained, but occasionally an owner objects, and he is thus able to block a

work which, if carried through, would be a great benefit to the whole community or town, including himself.

Legislation is therefore essential to provide for the systematic and wholesale draining of the salt marsh areas of the State.

SUMMARY.

The mosquito plague of Southern Connecticut is composed chiefly of two species of salt marsh mosquitoes—the brown salt marsh mosquito, *Culex cantator* Coq., and the banded salt marsh mosquito, *Culex sollicitans* Walk., which breed in the brackish stagnant pools of the salt marshes and fly inland several miles in search of their food, viz. the blood of the higher animals.

The rain barrel mosquito *Culex pipiens* Linn. breeds in rain water barrels, tin cans and other receptacles along the shore, and certain other species of *Culex,* as well as the malarial mosquito, *Anopheles,* may breed in the fresh water pools next to the highland, yet these are all local, fly only short distances and form only a small part of the mosquito plague of the coast region.

The salt marsh region of Connecticut contains 34.79 square miles, or 22,264 acres, more than half of which has in past years been drained for salt hay farming. During recent years the marshes have received little attention, the ditches have become filled and probably breed more mosquitoes than they did thirty or forty years ago.

The conditions are such as to check the proper and natural development of the Connecticut coast region as a site for summer homes; the land produces little, and is unprofitable, yet taxes are collected upon it.

Tide gates in proper working condition will keep tide water from flowing over the marsh but do not prevent the fresh water entering the marsh from the highland. This must escape to the ocean and draining is the only treatment to be advised. Narrow deep ditches are much more permanent than broad shallow ones. The lateral ditches should be not more than ten inches wide and from 24 to 30 inches deep, and placed from 100 to 150 feet apart, running parallel with each other, and nearly at right angles to the main stream or the broad central ditch.

The cost of draining the Connecticut marshes will vary, but may be done by contract at from $5.00 to $10.00 per acre, and

should not average more than $8.00. The entire salt marsh area of Connecticut can be drained for less than $200,000.00.

The increase in yield of salt marsh hay will soon pay the cost of draining and may do so in a single season.

Mosquito wrigglers may be killed by oiling the breeding pools, but this should be considered as only a temporary measure and should not be advocated in place of draining.

The methods of draining and oiling are shown on the plates, and described in detail on the pages of this report. Coöperation of individuals and communities are necessary for successful results in this work, and many towns and communities have taken it up. Legislation, however, is needed, and a State-wide movement with some State supervision would seem to be the best solution of the problem.

MOSQUITO CONTROL WORK IN CONNECTICUT IN 1912.

During the year there has been much interest shown in the subject of mosquito control, and a number of requests were made to this office for the examination of suspected breeding areas and for expert advice regarding treatment. Much has also been accomplished in draining marsh areas, and this paper describes briefly each area examined and also contains a summary of all draining operations to control the mosquito nuisance. For convenience each section or locality is discussed separately.

Greenwich.

In response to a request for an expert, Mr. Walden visited Greenwich on June 10th, and in company with Dr. E. O. Parker, chairman of Mosquito Committee, Board of Trade, and Mr. Edwin M. Skinner, president of the United States Drainage and Irrigation Company, examined the section within a radius of about one mile of the town hall.

Mr. Walden reports:

"1. At the foot of Nigger Hole Hill is a stream with a series of swampy areas along its course. There is considerable standing water in these places in which mosquito larvæ or wrigglers were breeding. The stream should be cleaned out and deepened so that it will drain all standing water.

2. Near Edgewood Inn is a small swamp with bogs and grass more or less covered with water. Mosquito larvæ were present in the water and many adult mosquitoes were found around the edges. In one direction the land is much lower than the swamp and a single ditch leading to this will give thorough drainage.

3. There is a low area at the right hand side of Prospect street with standing water all through the grass and weeds. This could be drained across the street to a brook on the left hand side which is much lower than the street.

The three above mentioned sections are ideal breeding places for the malarial mosquito (*Anopheles*), which will certainly be found there later in the season. The section near Prospect street is especially dangerous because there are many people living in the immediate vicinity.

Any one of the three places can breed enough malarial mosquitoes to infest the entire borough. Owing to the prevalence of malaria in Greenwich now the conditions will be much worse later in the season when the *Anopheles* become more abundant, if nothing is done to do away with their breeding places."

The Mosquito Committee conducted a campaign, issued literature, and obtained estimates for draining and filling sufficient to abolish the breeding places. The Board of Trade asked the borough officials for an appropriation for the work, but this was not granted, so no draining was done. Dr. Parker later reported a record of nine hundred authentic cases of malaria in Greenwich for 1912.

Stamford.

The drainage work here was done in 1911, and covered the entire coast line from the easterly shore of Bell Island to Shippan Point, a distance of about seven miles. Mr. W. L. Searles of Rowayton was chairman of the committee and was the leader in educating the people and arousing them to definite action. About $2,800.00, raised by voluntary contribution, was expended for draining 200 acres, and 125,000 lineal feet of ditches were cut. The residents are well satisfied with the work. This office had no part in this work, though in previous years the region has been examined twice and advice given.

Darien.

As in Stamford, the money was raised by voluntary contribution, and $3,800.00 was expended in draining an area amounting to approximately 300 acres of salt marsh and some inland swamps. The work was completed late in 1912.

South Norwalk.

In the work of South Norwalk and Darien, as well as in that of Stamford, Mr. Searles was the leading spirit. About 600 acres were here drained at a cost of $7,500.00, also raised by voluntary contribution, and the work was done in the summer of 1912. This office can share no credit for the campaign here or at Darien.

Fairfield.

The campaign in Fairfield was started by local initiative in November, 1911, and a committee arranged meetings and obtained contributions for the abatement of the mosquito nuisance. Six public-spirited citizens gave $1,000.00 each, and it was not a difficult matter to raise by voluntary contribution enough to make $8,400.00, which was the cost of draining 1,250 acres of salt marsh and some small inland areas. Before contracts were let, the Improvement Association of Fairfield and vicinity became incorporated and took charge of the work. Mr. Oliver G. Jennings was president and Dr. Valery Havard, secretary. No dues were required and a large membership was sought and about 300 joined the organization.

No oiling or other temporary measures were practiced at Fairfield, draining being the only means considered. The ditching was started in June and finished about August 1st.

The results are evidently satisfactory as Dr. Havard stated that the people were now able to use their porches with comfort afternoon and evening.

New Haven and Vicinity.

The Anti-Mosquito Committee, a sub-committee of the Committee on Sanitation of the Civic Federation of New Haven, instigated and, in coöperation with this office, planned a mosquito campaign. All other civic and health organizations were asked to coöperate and several meetings and conferences were held.

The officers of this committee were Dr. Louis M. Gompertz, chairman; Seymour C. Loomis, secretary; and Thomas W. Farnam, treasurer.

By means of illustrated and other lectures, newspaper articles and circulars the matter was agitated in early spring and the week beginning April 22d was set apart as "donation week" or "mosquito week" for raising funds. Through an effort organized and directed chiefly by the secretary named above a house-to-house canvass was made. Altogether nearly $5,000.00 was obtained by voluntary contributions in New Haven and vicinity, including adjacent portions of Orange and East Haven.

Fourteen lectures, treating of mosquitoes, were made by Messrs. Britton and Walden in or near New Haven. Five of these were illustrated with lantern slides, and most of the others were illustrated by specimens, photographs or charts. It is believed that much good resulted from the campaign aside from the money raised and the drainage and oiling work accomplished. An ordinance to prevent the breeding of house flies was passed by the board of aldermen, and a mosquito regulation adopted by the board of health. An appreciable advance was made in educating the people to recognize that these pests can be controlled.

Experts from this office examined the whole area several times in the season, both to locate breeding areas and to inspect the work of oiling and draining.

Before expending this money the Anti-Mosquito Committee was incorporated without capital stock, in order to put the work on a better business basis. Mr. P. L. Buttrick was employed as field agent, to have immediate charge of the oiling and other field work.

Draining.

The principal breeding places were drained, beginning at Morris Cove and extending eastward to Silver Sands, and including several separate small areas in the West River meadows. The area drained is estimated at 347 acres, and cost $3,567.00. Bids were first obtained on draining a certain area at Morris Cove, situated partly in New Haven and partly in East Haven and extending up both sides of Morris Creek, from its mouth northward as far as the salt marsh reaches. Three drainage

contractors visited the area and submitted bids. The contract was awarded to the lowest bidder, The United States Drainage and Irrigation Co., 17 Battery Place, New York City. There must be a new tide-gate built on Morris Creek below South End road before the full benefit of the ditching will be realized. The property owners expected to build one, but have not done so. Included with the Morris Cove area, in the first contract was a small plot of twelve or fifteen acres in Fort Hale Park. This area was in bad condition and needed draining. The land is owned by the United States Government but is turned over to the City for use for park purposes. The work on this contract was completed early in July. The ditches were inspected by Mr. Walden on July 22d, and again on July 29th in company with Mr. E. M. Harvey of The United States Drainage and Irrigation Co.

Later this firm was employed to drain the South End marsh on a basis of a footage rate per lineal foot of ditch. On account of lack of funds, this marsh, especially at its eastern end, was not entirely drained, though most of the mosquito breeding was stopped in it. Nevertheless about 10,000 feet more of ditches are needed there to perfect the work, and should be cut as soon as funds are available.

Though the worst breeding places were drained first, it was thought best not to expend all of the money for permanent work in the same section. The West River meadows contained several small areas that needed treatment, and contracts were awarded to the same firm to drain two such areas; one west of the river between the New York, New Haven and Hartford Railroad tracks and Washington Avenue, and the other on the east side between Congress Avenue and the Derby Railroad. This work was done in August and was all examined August 21st, by the State Entomologist, in company with Mr. P. L. Buttrick, field agent of the Anti-Mosquito Committee and Mr. Edwin M. Skinner, president of the United States Drainage and Irrigation Co. Mr. Skinner recognized a few defects and promised to, and later did, send his men to remedy them. This drainage work, while on the whole satisfactory, must be extended over nearly all of the salt and some of the fresh marshes around New Haven, before the mosquito nuisance can be entirely eliminated. Draining, filling or dredging, i. e., permanent work

should be executed wherever possible, and other measures should be regarded as of doubtful expediency.

Oiling.

The committee early planned to keep oiled through the season such breeding areas near the city as could not be drained. Though a simple matter in fresh water pools and receptacles it is a difficult one on large salt marshes. These areas are flooded at the perigee or very high tides, which though not as high in 1912 as in some seasons, came oftener and the meadows were flooded longer than usual, making it all along the Connecticut coast one of the worst mosquito seasons within the memory of the residents.

On much of the salt marsh area the grass is not cut for hay but water stands in it deep enough and long enough to produce mosquitoes. The presence of the grass interferes seriously with applying the oil to the surface of the water. Where the water occurs only in pools the matter is comparatively simple, but in late summer and early fall the very worst breeding places were in the grass, and many of these areas showed no signs of breeding in the spring and early summer.

At first the oiling was done with small knapsack compressed air sprayers. The "Auto-spray" shown on plate XIII made by the E. C. Brown Co., Rochester, N. Y., was first employed, being available, light and inexpensive. But this pump did not prove to be very durable and later one of the "Simplicity" pumps, made by the McCormick Manufacturing Co., of Dayton, O., was ordered.

No work was done on the Quinnipiac marsh, but all other marshes near the city not drained were oiled. As the grass breeding became more extensive and intensive toward the latter part of the summer more powerful pumps were needed, and a Hardie Wheel Outfit was procured. After a trial, the "Double-Forester," designed for fighting fires and made by W. & B. Douglas, Middletown, was purchased. Both of these pumps were quite effective, though requiring two men to each outfit. Each pump is sufficiently powerful to throw a heavy spray or solid stream for some distance, and it is unnecessary to walk over the entire area as is the case with the smaller outfit. But even larger outfits were given a trial. When the

breeding season was at its height Mr. Buttrick borrowed some barrel spray pumps, such as are used for spraying trees, and hired extra men to use them. By such means he was able to head off one brood of mosquitoes which was in danger of emerging before the territory could be covered by his regular force with the small pumps.

Altogether nearly $1,000.00 was expended in oiling. It is rather expensive, costing on the salt marsh about one-fourth to one-third as much in one season as to drain the same area. The drains, with slight attention, are effective for many years, but the oiling must be repeated with the subsidence of every high tide.

For part of the work kerosene was used, chiefly because it could be procured at a reasonable price at every corner grocery, often saving expense in the time of the men, if it had to be carried long distances from a central distributing point. But later in the season when more oil was used several barrels were purchased of a heavier oil, known as "light fuel oil" or "34° distillate," and a barrel placed near the center of each particular area where it would be used. This oil is somewhat less expensive than kerosene, and lasts longer upon the surface of the water. It is probably more destructive to vegetation, and to animal life in the water than kerosene—though both kill mosquito larvæ readily. The Park Commissioners oiled the breeding places within the public parks.

From the actual cost of doing the work, Mr. Buttrick computed that for the early brood the cost per acre might be as low as three cents. In midsummer the cost was about sixteen cents per acre per brood, while for the heavy broods of August and September the expense probably reached $1.00. The average per brood would probably be nearly fifty cents per acre. If there are seven broods in a season it will be seen that the cost of oiling alone may amount to $3.00 or more per acre, for a single season.

As most of this marsh land can be drained for less than ten dollars per acre, systematic oiling is hardly to be advised.

Future Work Around New Haven.

In order to be practically rid of the salt marsh mosquito nuisance, more draining must be done next year. This should

include the area on the east side of the harbor north of Fort Hale Park, portions of the Mill River meadows, Quinnipiac marsh, West River meadows, and at Sandy Point, Old Field Creek and Cove River marshes in Orange. Additional ditches should be cut at South End, and there are still other marshes in East Haven between Momauguin and the Branford line. The City of New Haven should also drain Beaver Swamp, where malarial mosquitoes breed abundantly, and all other breeding places within its park area.

Corporations Interested.

Several transportation and manufacturing corporations have shown sufficient interest in the subject to have their marsh land examined and estimates obtained for draining it. For the most part the estimates were submitted late in the season and action was deferred until the following spring.

Branford.

In 1911 some draining work was done north of Short Beach, and several years ago Mr. Wm. A. Bryan, at his own expense, drained many acres of salt marsh near Indian Neck. Dr. Chas. W. Gaylord has also at different times exercised his authority as health officer to drain areas where malarial mosquitoes were breeding. Several years ago the residents of Pine Orchard raised money and drained a small marsh and oiled other areas near that settlement.

Early in 1912, Dr. Wm. H. Carmalt, chairman of the House Committee of the Graduates Club, asked us to make an examination of the marshes in the vicinity of Double Beach, the hotel there having been rented by the Club. Mr. Walden, with the help of Mr. Kirk, examined this area. That portion west of Double Beach was examined on May 10th, and the remaining portion west, as far as Branford River, on May 20th. Had the examination been made in July, August or September, mosquito breeding would have been found far more extensive, as is the case in all salt marshes. Mr. Walden's notes refer to breeding places located on maps by means of numbers and are as follows:

Marshes west of Double Beach, examined May 10, 1912.

"603. At entrance of hotel grounds on both sides of drive, there is standing water in which wrigglers were breeding (fresh water species).

604. Holes blasted in the ledge, which hold water and in which fresh water wrigglers were found.

605. This whole marsh area is in bad shape. The old ditches are choked and the marsh is soggy, with much standing water, in which salt marsh wrigglers (probably *Culex cantator*) were abundant. It will be necessary to reditch this whole section to prevent breeding. The worst breeding is across the north end and down the east side, next to the road covered with crushed stone. Near the entrance to the private place there is breeding on both sides of the road.

606. Small, soggy areas which need draining. Wrigglers were present in all standing water.

607. Small marsh of two or three acres across the south side of which is a roadway with stone retaining wall next to water. Towards the west end was a sluiceway through which flows the stream that drains the marsh. This sluice has collapsed, choking the stream so that the marsh contains standing water, especially on the north and east sides. The water contained large numbers of wrigglers. The sluiceway should be repaired and small ditches should be dug from the edges of the marsh to the main stream.

608. In the whole upper half of this marsh and west of the stream down to the road where the trolley runs, mosquitoes are breeding abundantly."

Marshes east of Double Beach, examined May 20, 1912.

"609. Small marsh north of Double Beach Hotel; a few wrigglers were found. A single ditch from shore to west side of area will drain all standing water.

610. The west and north portions of this marsh have much standing water, and mosquitoes are breeding in it. Should be drained.

611. South edge of this small marsh next to high land has choked ditches with standing water and is breeding mosquitoes.

612. A low marsh flooded by tide when examined. No mosquito breeding found.

613-614. Water standing at these spots, containing wrigglers.

615-616. Standing water which may breed mosquitoes later in the season.

617. Sparse breeding along the edge of marsh.

618. Upper end of marsh, where the drainage has been cut off by a road crossing to a sand bank on west side.

619. This marsh is in very bad condition. The whole area is in need of ditching. The worst breeding spots in the sections are marked 619."

Estimates were procured on draining these marsh areas, but nothing else has been done. Possibly next season may bring some definite action.

In May, 1912, Mr. David Daggett of New Haven applied to this office for an expert examination of the region about Pine Orchard, to learn what measures should be adopted to eliminate the mosquito nuisance there. As we were all busy, at our suggestion, Mr. P. L. Buttrick was employed for this purpose by Mr. Daggett, who requested that the report be submitted to this office for approval before further action on it was taken.

The examination was made during the latter part of May and a report of six typewritten pages and a map was submitted for my approval May 29th. This report covers the coast from Branford River to Stony Creek and includes data on fresh as well as salt marshes. The suggestions for treatment have not been adopted as far as I can learn, so there still remains considerable work to be done in this section.

Guilford.

A citizen of Guilford is authority for the statement that the selectmen have caused to be drained certain sections of marsh land in that town. I do not know the area treated nor in what year the work was done.

Old Saybrook and Old Lyme.

My first knowledge of any attempt at mosquito control near the mouth of the Connecticut River resulted from the call at my office of Mr. Brooks on May 17. He stated that at Fenwick, where mosquitoes had been quite a nuisance, the residents had determined to use an abundance of oil, floating it in on the tide

as a relief measure. I advised him that draining was the proper means, and cautioned him against expending too much money upon oil.

Nothing more was heard from this section until October, when I received a letter from Mr. R. A. Rutherfurd of Black Hall, who had planned to procure estimates on draining the entire area, a portion of which lies in the town of Old Saybrook and the remainder in Old Lyme. Mr. Rutherfurd obtained estimates, saw the residents most interested and enlisted their support, then arranged for two meetings on November 1st, one at 4 P. M. in Old Saybrook and another at Old Lyme at 8 P. M. A representative of the United States Drainage and Irrigation Co., which made the estimate, was present, and the State Entomologist gave a brief talk at each meeting. Since that date a committee in Old Lyme has organized an Anti-Mosquito League and in all probability some draining will be accomplished next season.

Fresh Water Breeding Places.

On May 16th, at the request of Dr. Wm. H. Carmalt, I visited the property formerly known as Lion Park, now owned by the New Haven County Anti-Tuberculosis Society, on Campbell Avenue, West Haven, making an inspection of possible mosquito breeding places on the property. The following report was submitted to Dr. Carmalt:

"That portion fronting on Campbell Avenue, where several drains have recently been installed, is now in good condition. There is a little moisture above ground, due to the recent heavy rains, but I believe this will entirely disappear after a few days of pleasant weather. The only portion of the ground which needs any treatment is the brush-covered area near the southwest corner. There is more or less water standing in the depressions scattered over a part of this area, and the deeper pools, or nearly all of them, contain mosquito larvæ, some of which are nearly full grown. These are probably *Culex canadensis,* one of the species which breed in woodland pools early in the season. The brush here grows so thickly that it is difficult to get through it to make a careful examination of this part of the grounds. Kerosene should be put on these pools at once, in order to kill the larvæ now in them. The oil can be

applied easily on these small pools with an ordinary sprinkling can, though it is necessary first to cut some of the brush in order to get at them.

I believe that the best treatment for this area is to cut a ditch perhaps eighteen or twenty inches deep and a foot wide, running through the center of the swampy area in a westerly direction or perhaps a little north of west, following the natural drainage line to the swamp near the railroad back of your property. Perhaps it will be necessary to cut a few short lateral ditches leading into the larger breeding pools, using the material removed from the ditches to fill in the small depressions. This work, of course, can be done under the direction of any engineer or contractor, and presents no particular difficulties.

I presume there is more territory west of your property which also needs draining, though I did not look over the adjoining field."

On June 20th, 1912, at the request of Dr. W. S. Lay, health officer of Hamden, I accompanied him in his automobile, from the corner of Whitney and Putnam Avenues, to look at some stagnant pools which he regarded as unsanitary.

First we went through Putnam Avenue, to where a small sluggish stream crosses upper Newhall Street. This stream comes from the vicinity of Prospect Street, near the base of Mill Rock, and crossing Newhall Street, enters the swamp owned by the New Haven Water Company. A high wire fence prevented us from examining the water on this property, but where it crossed the street, as well as above it, was in a filthy condition. Though the water was tested at a few places for wrigglers, none were found. Dr. Lay pointed out a number of houses nearby where undoubted cases of malaria occurred last year and this spring. This seemed to be the source of the malarial mosquito. From the condition of the stream and swamp it must surely breed malarial and other mosquitoes later in the season, and should be regarded as dangerous, at least in its present condition. The Water Company should cut, on its own property, a deep central ditch, sufficiently broad to carry off the water, with a few laterals to drain the margins of the swamp. The material excavated should be used for filling depressions between the ditches. Above Newhall Street, the bed of the

stream should be cleared and straightened, some of the brush cut and the water stocked with minnows. Several coves in the margin of the upper part of Lake Whitney receive surface water from the surrounding territory and are separated from the main part of the lake by sand bars which are supposed to act as filters. These cut off parts of the lake, must certainly be mosquito breeding areas at times and should be given attention. The margins are shallow and more or less grown up with vegetation. Even if stocked with fish there would probably be mosquito breeding around the edges.

We then went north and west, where, between Dixwell and Circular avenues, and south of Cherry Hill we found a large stagnant pool, of perhaps eight or ten acres in extent. Apparently this pool has no outlet, but the water is shallow and grass grows through it over most of the surface. We did not test this pool for mosquito breeding. At Mt. Carmel post office we turned to the east and then to the north, into the road running parallel with the trolley tracks. At a point directly back of Mr. Woodruff's, opposite the vicinity of the Station farm, there are at least three sink holes, each containing a foot or more of water, all more or less grown up with brush, the present species being button bush, and half of the bushes were dead. Various aquatic plants grow around the margins, the latter so covered with brown scum that it was difficult to examine the water. Adult mosquitoes, resembling *Culex pipiens*, fairly swarmed here. We did not succeed in finding larvæ, and on account of the soft mud around the edges and the lack of rubber boots, it was impossible to make tests except in a few places. These places were formerly drained into the stream which is only a short distance eastward, but the ditches need to be deepened and the brush should be cut to let in the sunlight and to facilitate the work of draining and oiling. These places are on land either owned or controlled by the New Haven Water Company, and should receive attention at once, as the residents of the vicinity have already entered a complaint.

Returning to the trolley line at Mt. Carmel center, the commencement of the old canal and at the south end, near the railroad station we found one malarial wriggler in the water.

Advised Dr. Lay to work for the permanent draining of this canal, and to fill portions of it, if not possible to drain it entirely.

Organized Effort Toward Legislation.

Knowing the interest in the subject of mosquito suppression, and its importance to the people of the State, the Station called a meeting for September 17th, and invited all men to attend who were known to be interested in the object of the meeting. Nearly one hundred invitations were issued, but less than twenty were present. Many letters were received from others expressing their regret that on account of previous engagements they were unable to be present. Dr. Gaylord of Branford was chosen chairman. The situation in all its phases was discussed, and the speakers were unanimous in declaring legislation necessary. Consequently it was moved that the chairman appoint a committee of five to further consider the matter and, if it saw fit, to draft bills to be introduced into the next legislature, the committee to report at another meeting to be called prior to January 1st, 1913.

The committee, of which Dr. Chas. J. Bartlett of New Haven was chairman, met twice and decided upon two measures, one providing for the drainage of the larger marsh areas, and the other giving more authority to the health officers to remedy local mosquito troubles. These bills were submitted to the people attending the second meeting at the Station, November 22. Through a suggestion made at this meeting, a portion of the second bill was omitted and the matter covered by an amendment to Section 2526 of the General Statutes (Revision of 1902). The meeting then voted approval of these three measures and the chairman was empowered to appoint a committee to acquaint the people with these proposed laws and to support the bills at the legislative hearings. Dr. Wm. H. Carmalt of New Haven was appointed chairman of this committee.

The following table shows the approximate number of acres of marsh land which have been drained recently, and all but the Stamford work was done in 1912. Moreover, the cost, which is also shown in the table, was borne by voluntary contributions:

Mosquito Drainage Work in Connecticut.

Location.	Approximate Acreage.	Cost.
Stamford	200	$2,800.00
Darien	300	3,800.00
South Norwalk	600	7,500.00
Fairfield	1,250	8,400.00
New Haven	347	3,567.00
Total	2,697	$26,067.00

OUTBREAK OF THE FALL ARMY WORM.

Laphygma frugiperda S. & A.

On September 3d a few specimens of the larvæ were received from Mr. Fred Hoadley of Stonington, where they were devouring the grass of a lawn in the village. The caterpillars were collected on August 31st, and Mr. Hoadley reported that they seemed to eat grass only, and had destroyed the lawn. Mr. Hoadley had sprayed the remaining grass with lead arsenate, which killed the larvæ.

On September 10th a large number of larvæ and pupæ were brought to my office from the lawn of Mr. Thomas Hooker, 51 Hillhouse Avenue, New Haven, where they were rapidly devouring the grass. Many of the larvæ had Tachinid eggs fastened upon their heads and bodies, showing that they were strongly parasitized.

The next day, September 11, in response to a request, I visited Branford House, the residence of Mr. Morton F. Plant at Groton, to examine the work of this insect. Several acres of lawn had been entirely devastated and the ground was being disked preparatory to reseeding. Many of the caterpillars here had pupated though some were still small, and apparently about half grown. Here also were many Tachinid eggs indicating that parasites were present.

On September 11th another box of specimens was brought to the Station by Mr. William Roberts, from the field of his neighbor, Mrs. Upson. In this case the larvæ were devouring millet and doing considerable damage. These also showed evidences of parasitism and there were pupæ in the box.

On September 22d adults emerged from the material collected at Groton and also from New Haven material. Adults continued to emerge until October 9th.

Dr. Felt* reports that this insect was very abundant in the vicinity of New York and on Long Island the latter part of September and the first part of October. It attacked lawns chiefly, but injured corn on Long Island.

From a circular issued August 31st, by the Secretary of Agriculture, it appears that this insect has this season caused

* Journal of Economic Entomology, Vol. 5, p. 403, October, 1912.

great destruction of crops in the Gulf States and northward, attacking nearly all kinds of vegetation, but especially grass, corn, alfalfa, cow peas, cotton, sugar cane and rice. The fall army worm was not the only offender in this southern invasion but was accompanied by the true army worm *Heliophila unipuncta,* Haw., and by the cotton worm *Alabama argillacea,* Hübn. In Connecticut, however, these two last named species were not seen in the adult stage, though the army worm is probably present in small numbers and several adults have been taken at light each season.

Description and Life History.

The adult of the fall army worm is a moth belonging to the family Noctuidæ, and has a wing expanse varying from one and one-fourth to one and one-half inches. The primaries are narrow and in the male are often without prominent markings, being uniformly mouse grey. The female has conspicuously mottled primaries, which can be seen better than described if the reader will examine plate XIV, a, of this report, where both sexes are shown. The secondaries in both sexes are nearly white, semi-transparent and iridescent, with a dark border, which is broadest at the apex, and gradually diminishing and disappearing altogether before it reaches the inner angle.

Body mouse grey, somewhat lighter than the primaries. The females lay pearly-white ribbed eggs in clusters of 50 to 60 and covered with mouse-colored hairs from the abdomen of the parent. These eggs are laid on the leaves and stems of grasses and when abundant the females often deposit eggs on the leaves or twigs of trees, walls, fences and buildings. The eggs hatch in about ten days and the young begin to feed upon their favorite food plant, which is usually grass of various kinds, with the cereals as second choice, followed by the other crops mentioned. There are probably two generations in this climate and the larval period is not well known here. It probably varies greatly in different seasons. Our collection contains several adults collected in Maine between August 10th and September 7th. The late appearing female moths lay eggs, but from studies made at Washington, D. C., a few years ago, it appears that though these eggs hatch and the larvæ feed until cold weather, then go into the soil, that they are not able to

survive the winter. In most cases the adults do not emerge in the fall, but pass the winter as pupæ and appear the following May. As we have a good supply of material we hope to be able to make further observations on the life history of this insect.

The full grown larva varies from one to one and one-half inches in length and somewhat resembles the common army worm but is darker in color. The Stonington specimens were described as follows:

Length 28 mm. (1⅛ inch): thickness 3 mm. Color dark purplish grey or black dorsally, greenish or light brown ventrally. A spiracular lateral stripe extends longitudinally, with yellowish ground-work faintly marked with light brown. There are narrow, broken, subdorsal lines of cream color, with faint parallel tracings between them. The first segment has a well-defined, cream-colored dorsal line which disappears entirely on the second or third segments. Anal segment with cream-colored dot. Head black, shining, with an inverted Y-shaped, cream-colored, facial mark. Antennæ white with black tips. Legs brown. Each abdominal segment shows dorsally six black tubercles, the front pair being nearer together than the rear ones, the lateral pair being distad of the front and caudad of the rear pair. There are two rows of black tubercles below the yellow spiracular stripe. Each tubercle bears a short black and rather stiff hair.

The pupa is about five-eighths of an inch long, brown and much resembles the corresponding stage of other Noctuid moths. Larvæ, pupæ and adults are shown on plate XIV.

Natural Enemies.

I have already mentioned that the larvæ were parasitized. Three female Tachinid flies emerged October 5th, from the Groton material. These were identified by Mr. Harrison E. Smith of the Bureau of Entomology, as *Winthemia quadripustulata* Fabr., a species common on this as well as on other hosts. Chittenden* mentions another fly, *Frontina frenchii* Will., of the same family reared from material collected at Columbia, S. C. He also mentions the Hymenopterous parasites, *Apanteles*

* Bureau of Entomology, Bull. 29, p. 36, 1901.

laphygmae Ashm., MSS., *Limneria dubitata* Cress., and *Euplectrus comstockii* How., as having been bred from the larvæ. Several specimens of wasps are known to attack the larvæ in the Southern States and the larva of a ground beetle, thought to be the fiery ground beetle, *Calosoma calidum* Fabr., is known to prey upon them. This beetle is common in Connecticut.

Control Measures.

Lawns may be sprayed or drenched with an arsenical poison, preferably lead arsenate, to kill the larvæ which feed upon it. This was used by Mr. Hoadley with good results at Stonington, and would be particularly effective in the early stages of the damage before the larvæ are fully grown. It usually happens, however, that the larvæ remain unnoticed until they have made their work conspicuous, and by that time many have transformed to pupæ. It is then too late to poison them. Applications of kerosene emulsion, followed with copious drenchings from the hose, is said to be effective.

There are several mechanical measures that may be employed. One of these is to roll the ground in early morning or in late afternoon when the larvæ are feeding, going over the land several times with a heavy roller.

At Groton a disk harrow was employed to cut up the turf, to make a suitable bed for reseeding the lawn. Possibly this treatment was unnecessary. Even though the grass was wholly devoured above ground it would come up again and be green if the crowns of the plants or the rootstocks were not destroyed. Nevertheless, the harrow was in operation when I visited the place and I advised that it be driven over the lawn many times in different directions to kill as many as possible of the larvæ and pupæ.

As most of the insects winter as pupæ in the soil, late fall plowing may be regarded as an important control measure, especially on land where the field crops have been attacked and injured. It is not advisable for lawns. If large flocks of chickens or turkeys can be placed upon an infested field, no doubt many of the larvæ and pupæ will be devoured.

Attention should be given this insect next year, as the fall army worm sometimes causes considerable damage earlier in the season.

SERIOUS INJURY BY WHITE GRUBS.

In the report of this Station for 1909, page 372, there was published a short account of injury to grass lands that season by white grubs. Judging from observations, correspondence and other reports, this injury in 1912 far exceeded that of 1909, and not only was grass damaged but various cultivated crops such as strawberries, corn and even potatoes were badly injured.

Specimens of the grubs were received July 23d, from Botsford; August 22d, Bethel; August 23d, Noroton Heights; August 28th, Darien and Saugatuck; September 12th, Noroton; September 28th, Meriden; and October 15th, Fairfield. Inquiries were also received and answered from Colchester, Norwalk, Wallingford, Prospect, Cheshire, Watertown, Plantsville, Southport, Southbury, New York City and Hammonton, N. J. At Prospect, Cheshire, Noroton, Darien, Southport, Fairfield, Southbury, Meriden and New York City the grubs caused injury to grass in meadows and in one case on lawns. Injury to corn was the reason for inquiries from Botsford, Colchester, Norwalk, Wallingford and Cheshire. Mr. Filley reported a case in Southington where two acres of corn had been killed by the grubs. The inquiries from Bethel and Watertown reported strawberries as being the crop chiefly damaged, and serious injury to potatoes was the complaint from Noroton Heights, Darien, Saugatuck and Plantsville. Mr. Moss reports very serious injury to potatoes in West Cheshire. In one case a row five rods long furnished at harvest only thirteen good potatoes. On the land of the Northeastern Forestry Company at Cheshire, where several acres were devoted to potatoes, only about 25 per cent. of the crop escaped injury. Here, also, there was great damage to forest tree seedlings. White pine is the kind of tree grown there most extensively and it was the most injured, nearly 25 per cent. of the seedlings being damaged. Some of the seedlings lost their roots entirely, as shown on plate XV, a, while others were partly eaten off. Black locust and other kinds of hard wood seedlings were also attacked and injured, though to a less extent. The inquiry from Hammonton, N. J., stated that the grubs were destroying lettuce plants by eating the roots in the beds, where they were evidently intro-

duced in the compost, which is usually made of turf and stable manure. Professor Forbes found thirty-four grubs in a single hill of corn in an Illinois field.

The dry season seems to favor the increase and abundance of white grubs. Several such droughts in succession generally precede or at least accompany severe white grub injury. Normally, grubs are present in the soil and feed upon grass roots, but it is only when abundant that they cause conspicuous damage. Plate XV shows the adult beetle, larva and the injury caused by this insect.

Life History.

White grubs are the larvæ of May or June beetles, belonging to the genus *Lachnosterna* and to the family Scarabæidæ. There are many species in the United States, and our collection contains fourteen species taken in Connecticut. Probably several others occur here. Of this number *L. fusca* Frœh., *L. crenulata* Först., *L. hirticula* Knoch., *L. nova* Smith, and *L. fraterna* Harris, are the common ones and one or more of these are doubtless responsible for the damage to grass and hoed crops. Most of our material was examined by Mr. John J. Davis of Lafayette, Ind., who is working on this genus for the Bureau of Entomology. Though the exact life history has not been carefully worked out for each species, it is supposed that three years are required for the insect to pass through the entire period of development from the egg to the adult beetle. Most of this time is occupied by the larval period and passed in the soil. It is the last year as grubs when they are large and voracious that the larvæ do most of their feeding and consequently most of the injury. The work of the smaller and younger grubs of a later generation is probably seldom noticed, though usually occurring in the same field with the larger ones.

The eggs are laid in the month of June in grass land or cultivated fields, and are white, oval, and about one-tenth of an inch in length. Each egg is laid in a ball of earth perhaps a half inch in diameter and placed in the ground from one to five inches beneath the surface. In about two weeks the eggs hatch and the young grubs begin to feed upon the roots, growing slowly at first. At the end of the first and perhaps the second seasons the grubs go downward from seven to fourteen inches

below the surface to pass the winter. At the end of the last season the grub makes an earthen cell in the ground, and after three weeks there, changes to a soft, light brown beetle. It remains in the ground, however, until the following spring, when in May or June it emerges a dark, brown beetle with hardened wing covers. The adult beetles feed at night on the leaves of various trees, sometimes defoliating them. It is probable that the various species may have different feeding habits and food preferences, but these are not well known and must here be treated as if the same. The beetles hide through the day in the soil and may often be turned up with the rake or the spade in the garden. In early evening late in May and during the first part of June the beetles make much noise in their clumsy flight and certain species are attracted by lights and may be found in large numbers under arc lights.

Control Methods.

Like several other noxious insects, white grubs should be controlled by cultural practices rather than by the use of applications. Corn, strawberries and other crops commonly damaged by white grubs should not be planted on sod land as it is usually on such ground that the greatest damage occurs. Rotation of crops is apt to prevent this multiplication and it is where land is kept in grass for several years at a time that it is most seriously injured. If hogs can be turned upon infested land they will root it over and devour the grubs. Skunks have a similar habit, and I saw years ago in New Hampshire acres of grass so eaten at the roots that the turf could be rolled up like a carpet and the field filled with holes where the skunks had been digging after the grubs.

Fall plowing is to be recommended as it brings the larvæ and pupæ to the surface, where they are killed by freezing. If flocks of turkeys or chickens follow the plow they will eat many of the insects as will also blackbirds and crows.

Often the injury is noticed in midsummer, when it is advisable to plow the land and sow it to Hungarian or millet, thus getting another crop from it the same year. If the injury appears too late in the season for this practice, the land may still be sown to rye. In any case, whether the ground is plowed

in late fall or in spring, midsummer or early fall, it should be pulverized very thoroughly by going over it several times in different directions with a disk harrow to kill the larvæ or beetles. It is questionable if any application of chemicals, as is often advised, is worth considering. Common salt, lime, kainit and muriate of potash are sometimes recommended to kill white grubs, but the cultural practices mentioned are preferable; though any good fertilizer has a value other than for killing grubs.

MISCELLANEOUS INSECT NOTES.

A Gall-making Beetle of the Hop Hornbeam.—In April 1911, Mr. A. B. Champlain, then an assistant in this department, while visiting at Lyme, collected some branches of hop hornbeam or ironwood, *Ostrya virginica,* containing swellings or galls. On cutting open the galls, some were empty, while others contained borers, and a spiral gallery was visible. The branches were placed in breeding jars with the ends in moistened sand to prevent too rapid drying. In due time, on May 29th, three adult beetles were obtained. They belong to the family Buprestidae and to the genus *Agrilus.* They were sent for identification to Mr. C. A. Frost, South Framingham, Mass., who pronounced it a new species, and who was requested to describe it. Mr. Frost has named this species *champlaini,* in honor of the discoverer, and the description was published in the *Canadian Entomologist,* Vol. XLIV, page 245, August, 1912. The appearance of the gall is shown on plate XVI, c. Other specimens have since been reared by Mr. Kirk.

The Spruce Bud Moth, *Tortrix fumiferana* Clem.—This insect seemed to be unusually abundant in 1912. Several adults were taken at light on July 17th. On July 22d several adult moths were received from Dr. E. H. Jenkins, collected at his summer home, Pemaquid Point, Me., where he says that the larvæ defoliate and ultimately kill the spruce trees. The adults were mating at the time he collected them and the air was filled with them flying about. In a trip through eastern Massachusetts and along the coast in New Hampshire and into Maine during July, the writer also saw hundreds of these moths. In Connecticut, however, I have never seen them as abundant as they

were the past season. Occasional spruce twigs which may have been damaged by this species have been sent to this office. Two were received from New Haven and one from Stamford in 1911, but we were not able to rear the adult. An illustrated account of the destructive work of this insect may be found in the Fifth Report of the United States Entomological Commission, page 830, 1890, and a compiled account is given by Dr. Felt in his "Insects Affecting Park and Woodland Trees," page 416, 1906.

The moth has a wing-spread of an inch or slightly less, and the wings are finely mottled with light and dark brown. The winter is passed in the partly grown caterpillar stage among the terminal shoots of the branches, and in the spring the larvæ feed upon the leaves of the present and previous seasons' growth, making a web upon the terminal shoots and reaching maturity the last week in June. They then pupate in the loose leaves of their improvised nests, and in a week the adults appear. The eggs are laid in midsummer and hatch in ten days. There is but one brood each year.

Where choice ornamental and shade trees are attacked, they should be sprayed thoroughly with lead arsenate, using at least five pounds of paste or two and one-half pounds of dry powder in fifty gallons of water.

A Chrysomelid Beetle on English Ivy Imported from Europe.—While inspecting imported nursery stock in the spring, Messrs. Caffrey and Kirk found in one box containing several plants of the common English ivy, *Hedera helix,* some blue leaf-eating beetles which appeared to be feeding upon the ivy. The shipment came from Holland. All specimens found were collected, about fourteen in number. Through the kindness of the Bureau of Entomology, these were identified by Mr. E. A. Schwarz as *Agelastica* (*Galeruca*) *alni* Linn. Mr. Schwarz writes that the introduction of this beetle into the United States would be most undesirable. Though perhaps it is not regarded as an important pest abroad, it is included in Eckstein's "Forstliche Zoologie," page 442, 1897, and in Judeich-Nitsche's "Forstinsektenkunde," page 607, 1895, as skeletonizing the leaves of various species of alder. Whether or not it will attack and injure other kinds of foliage we do not know.

Southern Cabbage Butterfly in Connecticut.—Mr. Walden captured an adult Southern cabbage butterfly *Pontia* (*Pieris*) *protodice* Boisdv., at Yalesville, September 26th, 1912, while inspecting nursery stock. This is the first Connecticut specimen taken by any member of the staff of this department, though our collection contains a male and a female collected by Mr. H. S. Woolley of Waterbury and the species has been reported from several other localities in the State. Smith, in his list of New Jersey Insects, states that the Southern cabbage butterfly is common in some seasons in Southern New Jersey, though rarely found in the northern part of the State. Messrs. Walden and Caffrey observed wings of this species in a spider's nest and several adults were flying about at Yalesville. No doubt this butterfly is more common than we suppose and is usually mistaken for the much more common imported cabbage butterfly, *Pontia* (*Pieris*) *rapæ* Linn. *P. protodice* is the cabbage butterfly of the Southern States and the caterpillars feed upon the leaves of cabbage, cauliflower and other cruciferous plants.

Tolype velleda Stoll., Unusually Common.—This curious moth is closely allied to the tent caterpillar and belongs to the family Lasiocampidæ, some members of which are called "lappet" or "lackey" moths in Europe. At two or three different times during the course of our gypsy moth work, the men have found the caterpillars, at first thinking they were gypsy caterpillars, then noticing the difference. The caterpillars are very short and broad and are closely appressed to the bark, dull rusty or dark grey in color. The first specimen received at this office on July 27th, 1912, was a full grown larva from Centerhill, in the town of Hartland. On October 5th Mr. Stoddard of the botanical department brought in an adult collected in New Haven, and early in October the writer observed several of the moths resting on electric light poles about the city. On October 11th a box containing eight adults and three cocoons were received from Leonard Bridge in the town of Lebanon. The moths are grey and have a wing-spread varying from one and one-half inches in the male to two and one-fourth in the female. The primaries are crossed by white, undulating lines. The bodies have a woolly appearance, and are grey with a brown central stripe extending the length of the

thorax. The caterpillars fed upon apple, pear, cherry, maple, oak, willow, poplar and lilac, and will probably never be sufficiently common to be regarded as a pest.

The Elm Saw-fly.—This insect was rather abundant in 1912 and larvæ were observed in several places. On July 31st, a larva was received from Winsted, and on September 19th, three larvæ on willow were handed to the writer at Norfolk. The full grown larva is over an inch and a half long, head and body uniformly a light cream color with black spiracular dots and a narrow black or dark brown median dorsal stripe. (See plate IX, c.) The larvæ may be seen in the latter part of summer crawling down the trunks of elm, willow, poplar and linden trees, upon which they feed, seeking the ground to transform. Spraying the foliage with lead arsenate is the proper remedial treatment. If disturbed they curl themselves up like a snail shell. The adult is one of our largest saw-flies, also called "willow" or "giant" saw-fly and bears the name of *Cimbex americana* Leach.

Aphis on Potatoes.—On July 18th leaves of corn and potatoes were received from Mr. Noyes Palmer of Stonington, and from Mr. Alfred L. Beebe of Mystic, all infested with aphids which we took to be the potato aphid *Macrosiphum* (*Nectarophora*) *solanifolii* Ashm. This identification was later verified by Mr. Arthur I. Bourne of the Agricultural Experiment Station, Amherst, Mass. In 1903 this aphid was very abundant on leaves and stems of potatoes in Fairfield, and in July, 1909, Mr. Bourne, then an assistant in this department, found it on potatoes in the Station garden. In 1904 and the two succeeding years it caused serious damage in the large potato fields of Aroostook County, Maine, and Bulletin 147 of the Maine Experiment Station, by Dr. Edith M. Patch, is devoted to this species. Where plants are badly infested in small areas we may employ a spray of kerosene emulsion, but this did not seem practicable on large areas in Maine.

Tulip Tree Scale, *Toumeyella liriodendri* Gmel.—This is our largest scale insect. It is now attracting considerable attention and specimens were received during the season from Columbia, Fairfield, Greenwich, New Haven and Waterford. The female

scales are hemispherical, nearly one-third of an inch in diameter and brown in color. They are usually found upon and sometime kill the lower branches of tulip trees, afterward going to the higher branches. Small trees are often wholly infested. The males are much smaller and thinner. There is one brood annually, the young being born about September 1st. The proper treatment is to spray with kerosene emulsion during the latter part of September to kill the young. The old shells remain for a long time upon the twigs. Formerly this insect was placed in the genus *Lecanium,* and later was known as *Eulecanium tulipiferæ* Cook.

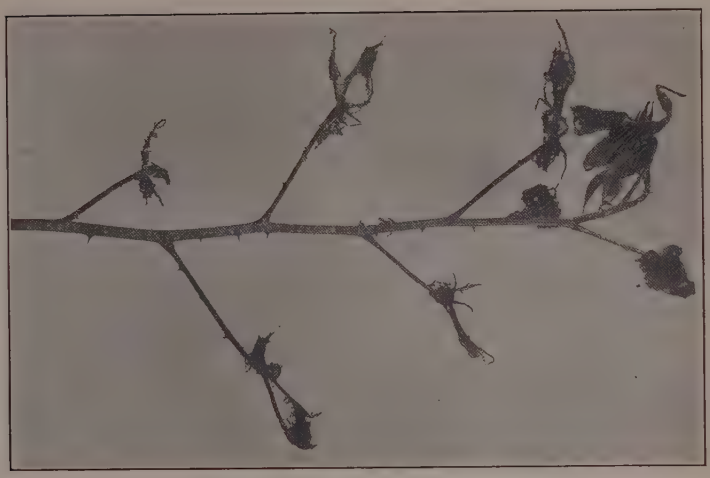
Juniper Web Worm, *Phalonia rutilana* Hubn.—On May 21st red cedar twigs were received from Wilton, containing a number of small webs. Though adults were not reared, the webs were probably formed by the Juniper web worm, which is described and illustrated by Packard in the Fifth Report, United States Entomological Commission, page 910, 1890. On November 4th, 1909, similar webs on dwarf juniper were sent to us from Greenwich. If choice or ornamental trees or shrubs are endangered a spray of lead arsenate will doubtless prevent further devastation.

The Garden Millipede or "Thousand Legs," *Julus hortensis* Wood.—On May 13th I was called to examine strawberry plants in a large field near New Haven. There were many dead plants, some no doubt having been injured the previous winter. The plants showed considerable tunneling in the main stems, probably the work of the strawberry crown borer *Tyloderma fragariæ* Riley, though only a few of the larvæ were present at the time of the examination. Many of the cavities, however, were literally filled with these millipedes (shown on Plate XVI, a, and b), apparently eating into the roots and crowns. In fact many of the cavities may have been eaten by them as they were very abundant on the field. At various times these millipedes have been sent to the Station, and reported as causing injury to plants. In Guilford in 1907 they damaged roots and bulbs in flower beds; in New Haven French anemones were injured by them in 1909, and beans in 1911.

The remedies consist of poisoned baits, such as slices of potato, turnip or some other succulent root, dipped in a mixture of lead arsenate, white arsenate or Paris green, about an ounce of dry powder or twice as much lead arsenate paste to two gallons of water. The bait should be distributed over the infested portions of the field.

Mites on Ash Tree.—On August 27th I was called to examine a white ash tree on Huntington Street, New Haven, opposite the Station grounds. The tree was perhaps six inches in trunk diameter, and it was literally covered, not only on leaves and stems, but on the bark of branches and trunk, with a silk-like web upon which were crawling myriads of mites resembling the common red spider of greenhouses. This web was so thick on the bark that it glistened in the sunlight as if covered with ice, though somewhat iridescent. The mites were fairly swarming down the trunk, evidently migrating to another tree, or perhaps to lay their eggs elsewhere. The leaves, which were badly injured, were turning yellow and dropping, the drought probably increasing or aggravating the trouble. Slides of these mites were sent to Mr. Nathan Banks, of the Bureau of Entomology at Washington, who identified the species as *Tetranychus bimaculatus* Harv.

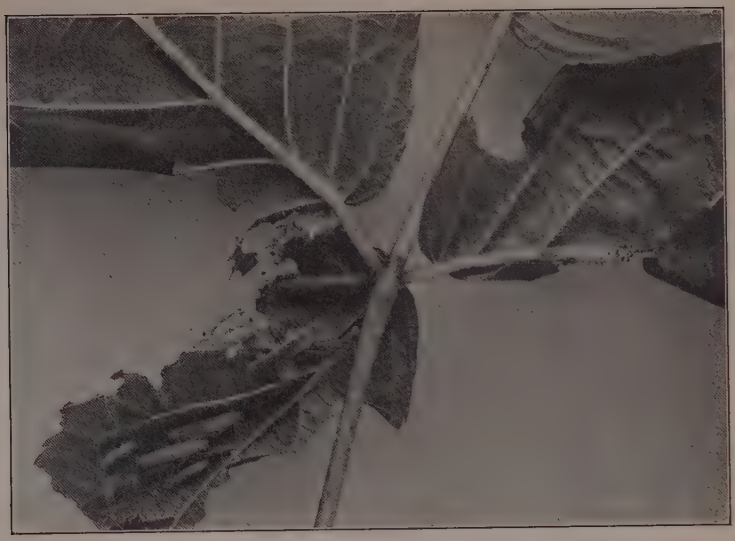
Mites on Chrysanthemum Flowers.—On November 14th, Mr. Kirk, when inspecting imported nursery stock at a florist's in Bridgeport was asked to examine some chrysanthemums which drooped and the petals withered and died. In a large flower, though freshly cut, dead and brown petals scattered through the blossom at once indicated that something was wrong. Though examined by both botanists and entomologists, the only parasites found were very small mites at the base of the petals. The mites seemed to be the cause of the trouble and were determined by Mr. Banks as *Tarsonemus pallidus* Banks.



a. Blackberry cane nearly defoliated.

b. Larvæ on leaf. Natural size.

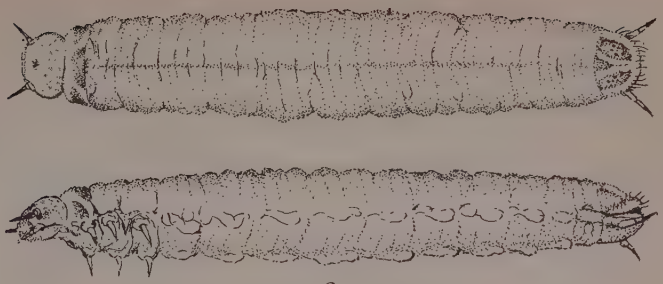
WORK OF BLACKBERRY SAWFLY.



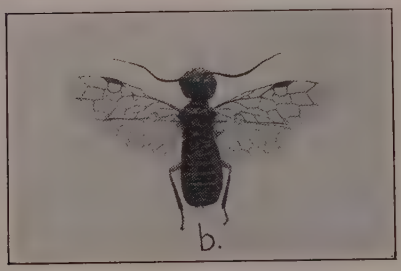
a. Leaf rolled by larvæ. Natural size.

b. Eggs on under side of leaf. Natural size.

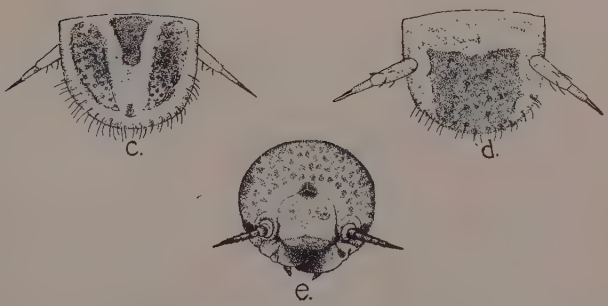
EGGS AND LARVÆ OF BLACKBERRY SAWFLY.



a.



b.



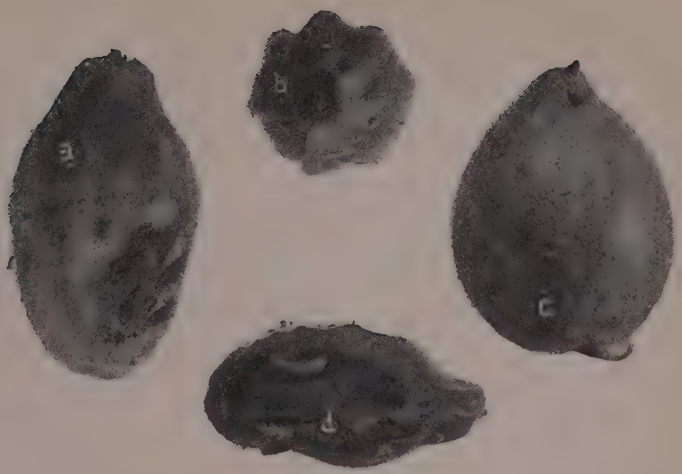
c. d. e.

a. Larvæ, about five times enlarged. b. Adult, twice natural size. c. Dorsal view of last segment of larva. d. Ventral view of same. e. Face of larva—last three ten times enlarged.

LARVÆ AND ADULT OF BLACKBERRY SAWFLY.

a. Feeding punctures at base of leaf petioles. b. Larvæ tunneling in new shoot. c. Shows where frass is ejected through egg punctures. d. Hickory probably attacked by this insect. All natural size.

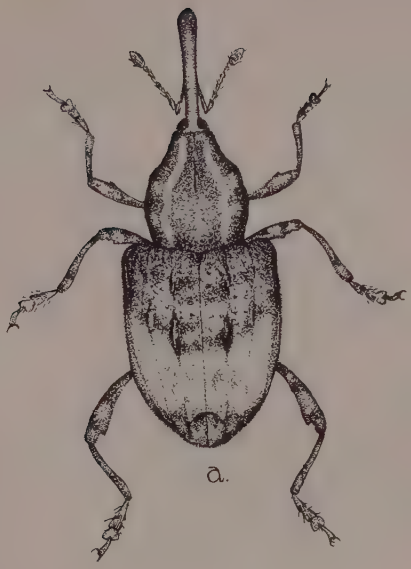
WORK OF WALNUT WEEVIL.



a. Appearance of infested butternut. b. Shows where grub had entered at end of butternut. c. Walnut showing egg puncture at tip. d. Grub inside of butternut. All natural size.

e. Small walnut tree showing method of studying the habits of the weevil.

WORK OF WALNUT WEEVIL.

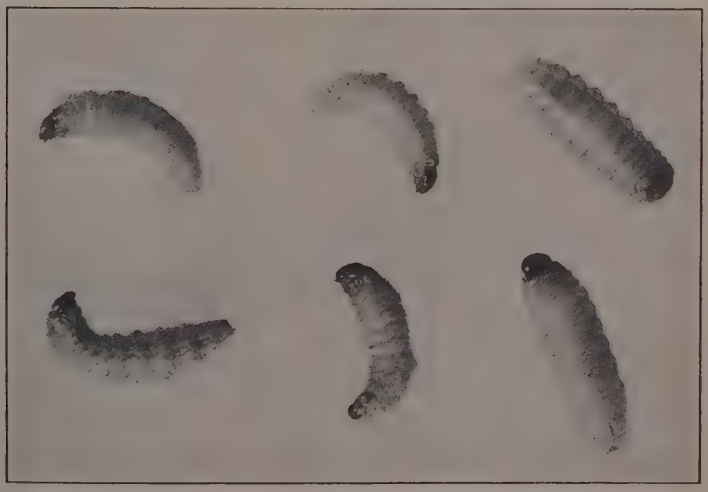


a. Adult. b. Larvæ. c. Pupa. All greatly enlarged.

ADULT, LARVÆ AND PUPA OF THE WALNUT WEEVIL.

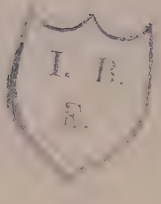
a. Walnut weevils. Four times natural size.

b. Egg as laid in stem. Natural size.



c. Larvæ. About two and one-half times natural size.

EGG, LARVÆ AND ADULTS OF WALNUT WEEVIL.


I. B.
E.

a. Nests at tips of new growth. Natural size.

b. Appearance of infested shoots, natural size.

WALNUT BUD MOTH.

a. Walnut Bud Moth, twice natural size.

c. Larva of Elm Sawfly. About twice natural size.

b. Arrow shows egg of Bud Moth. Enlarged two and one-half times.

d. Oiling mosquito breeding pools with the "Double Forester" pump.

WALNUT BUD MOTH, ELM SAWFLY AND METHOD OF OILING MARSHES.

a. Mosquito breeding pools on salt marsh near Morris Cove.

b. The same view as above showing ditch.

MOSQUITO DRAINAGE ON THE SALT MARSH.

a. The spade raised ready to be plunged into the peat.

b. Rolling away the turf.

DRAINING THE SALT MARSH WITH THE SKINNER SPADE.

a. The Skinner ditching spade.

b. This pool half way between ditches has been drained.

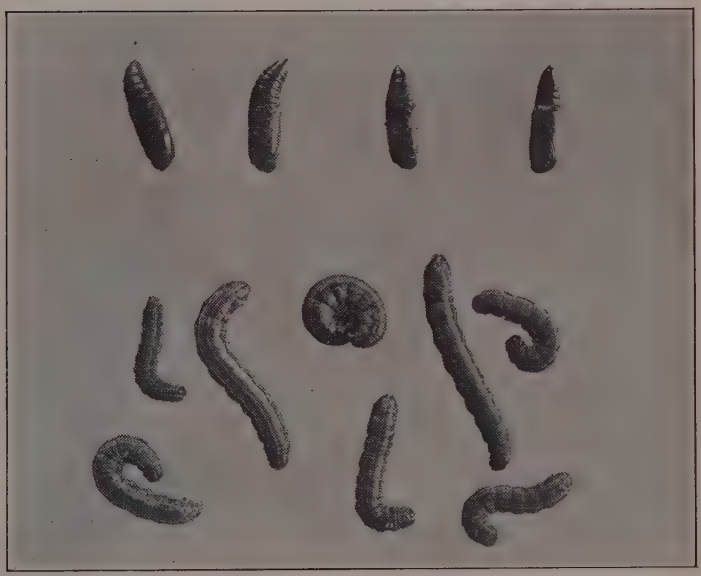
DRAINING OF SALT MARSHES.

a. Sandy Point marsh. Stakes and flags mark breeding pools.

b. Oiling pools in West River marsh.

OILING BREEDING POOLS WITH "AUTO-SPRAY" OUTFITS.

a. Adults, female at left. Somewhat enlarged.



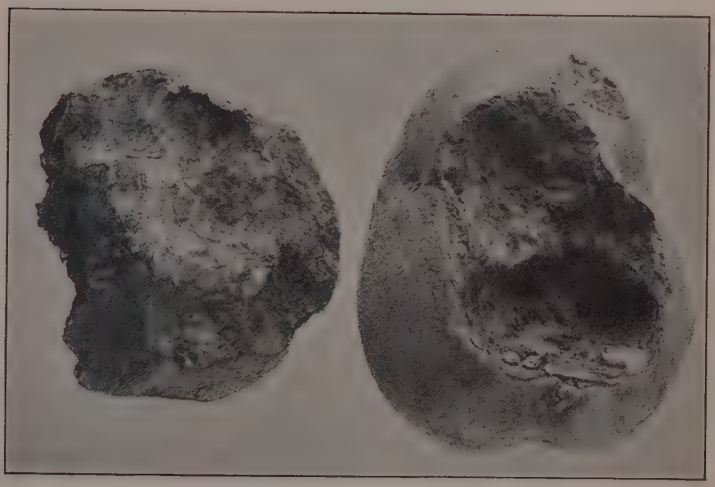
b. Larvæ and pupæ, natural size.

THE FALL ARMY WORM.

a. Seedling pine eaten off by grubs. Natural size.

b. White grub. Natural size.

c. Adult June beetle, natural size.



d. Potatoes eaten by white grubs.

THE WHITE GRUB.

a. Strawberry stem where millipedes were found.

b. Garden millipedes, natural size.

c. Galls of *Agrilus champlaini* on hop hornbeam.

GARDEN MILLIPEDE AND A BORER IN HOP HORNBEAM.

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